ENGINEERING NEWS

THE Board of Railroad Commissioners of New York sent in their decision, on Nov. 15, in the matter of the Buffalo grade crossings. They recommend the depression of certain of the streets and the elevation of the tracks crossing them. In some other cases the Board declines for the present to make recommendations, believing that the matter will right itself in time; but Commissioner KERNAN says the elevation of all the tracks is the best remedy proposed for existing difficulties, and the plan of bridging streets, as proposed by the railroads, is viewed with disfavor. This report is somewhat mildly starting in the right direction; but will do very well for a beginning. This system once inaugurated will soon assert its merits.

THE question of grade crossings is now being much agitated in Montreal and the same remedy is urged there as we have suggested as preferable for Buffalo and other flat cities, raising the tracks and depressing the streets to give under crossings. The accepted necessary headway in all cities seems to be 13 ft., that being the height proposed in the Jersey City works of the Pennsylvania Railroad. There is strong probability that the Montreal agitation will be successful, as it certainly ought to be. All our American towns and railroad companies should wake up to the fact that our present way of doing things is merely a surviving relic of past poverty and barbarism, and a disadvantage to both sides, as barbaric methods are apt to be.

ATTENTION is now being called to Pittsburg grade crossings of the Penna. R. R. and Vice Prest. MCCREA is reported as saying that the matter has been discussed in the directory and the general expression was that the change should be made at once. The remedy suggested here also is an elevated road.

A RECENT decision by the United States court at Chattanooga, Tenn., is of much interest in connection with the present agitation concerning grade crossings. The suit was brought by the Western & Atlantic Railroad Company against the city, to restrain it from interfering with trains standing on street crossings. Judge D. M. KEY decided that the city could enforce an ordinance subjecting train hands to a fine for each act of interference with street travel. An appeal has been taken to the Supreme Court, as this is a test case.

THE headings between Shafts 2 and 3, on the New Croton Aqueduct, met on Nov.1. These shafts are 6,200 ft apart and about 350 ft. deep. Before the last 8 ft. of rock were blown down the drills were set to true line and grade on each side, and when set to work they *met and struck each other*. This is exceedingly creditable to Div. Eng. CHARLES S. GOWEN and Asst. Eng. H. R. WHEELER who had charge of the lines.

THE following is the Bradford Ridge tunnel record, on the Louisville & Nashville R. R., Cumberland Valley Branch:—The tunnel is 843 ft. long; size outside of timbers, 18 ft. 6 in. by 23 ft. 8 in.; timbering in five segments; ground, heavy blue shale requiring permanent timbers throughout. The headings were commenced April 1, and finished July 15; the bench was started Aug. 13, and finished Oct. 20. The contractors were Mason, Hoge & Co.; subcontractors at tunnel Mason & Dickey. The Resident Engineer was M. E. S. POSEY, and the Division Engineer C. W. STANIFORD, the latter kindly forwarding this information.

THE last quarterly report of Gen. HUTCHINSON on the Forth Bridge is to date of August 31. Commencing at the South Queensferry Pier, the tower is up to full height with the top connections erected and partly riveted, and the horizontal and cross bracing riveted; the bottom members have been built out 152 ft. and 126 ft. from the centers of the vertical columns. The riveted work on this main pier now amounts to 4017 tons; 567 tons added in the quarter. At Inch Garvie pier the vertical columns are at their final level of 336 ft., with the bracing partially completed; the bottom members of the cantilevers are built out 120 ft. and 120 ft. respectively. About 4712 tons of steel work is riveted, or 1112 tons added in the quarter. The North Queensferry Pier is up to full height with the top connections practically completed; the bottom members are out 130 ft. and 120 ft. The total amount of riveted steel work here, is 4,295 tons, or 755 tons added in the quarter. Up to the date given 544,000 cu. ft. of granite have been set and about 110,000 cu. yds. of rubble masonry and concrete work have been built. The total amount of steel work riveted is now 45,157 tons, an addition of 3,757 tons since last quarter. The average number of men employed in the quarter was 3,748, with 4,204 men at work on August 31. The highest wind pressure observed has been 10½ lbs. per sq. ft. on the large gauge, and 18 lbs. on the small gauge. Several men have lost their lives in the quarter. It has been decided to build out the top members of the cantilevers for about 120 ft. without any supports.

THE Westinghouse experimental train of 50 cars to show the workings of the improved and, we may fairly say, perfected freight train brake, has now made a trip entirely across the eastern half of the continent from the far West to Boston, making exhibition tests at all the important railroad points, and, it seems clear from the accounts, bringing many railroad men to a realizing sense of its marvelous efficiency, which, when merely read about, produces little impression. There has been nothing so especially new as to call for detailed records of the stops, but that it has helped greatly toward the speedy introduction of freight train brakes can hardly be doubted. Tests are still contemplated at New York and many other points.

President CORBIN, of the Long Island Railroad, has renewed his application to the Brooklyn aldermen for permission to construct and operate an elevated railway from East New York through Atlantic Avenue to South Ferry. This application was once before rejected because he proposed to cross the proposed Union elevated road at grade and wanted more than two tracks on Atlantic Avenue. He now says he has an exchange agreement with and will cross the Union above grade at Flatbush Avenue and provides that there shall not be more than two tracks west of Flatbush Avenue. It is believed that the project will go though.

THE railroad accident record still continues gratifyingly light as respects serious disasters. The most serious accident of the week was a rear collision, Nov. 12, on the St. Paul, Minneapolis & Manitoba Railroad, near Glyndon, Minn. A freight train was pulling onto a side track at Averill siding, to allow a wild stock train to pass, when the latter ran into the caboose of the freight and telescoped it with the next car. Five men in the caboose were killed. The blame is laid to the engineer of the stock train, but it again illustrates the great excess of danger to and from wild or special trains.——Two misplaced switch accidents are reported; one near Hammond, Ind., on the Michigan Central Railroad, Nov. 8, the other at Macalester, Minn., on the Chicago, Milwaukee & St. Paul Railroad, Nov. 8. No one was injured in either case.

The following bridge accidents are reported: On Nov. 7, the bridge of the New York, Chicago & St. Louis Railroad across Twenty-Mile creek, near State Line, N. Y., was burned.——On Nov. 8, while an old wooden bridge acros the Maumee river at Waterville, O., was being pulled down, the structure gave way. Of 12 men on the bridge one was killed and five injured, some fatally. The span which fell was 170 ft. long, and the timbers were very rotten.——On Nov. 13 a heavy coal train on the Ohio Southern Railroad went through a bridge over the north fork of Paint river at Greenfield, O. The engine and 8 cars fell into the water. One man was killed.

MUCH damage has been done recently in North Carolina by rain and flood. The Cape Fear river rose 50 ft. above low water mark and other rivers rose several feet higher than since the freshet of 1882. Large districts of land are inundated and Princeville, on the Tar river, was flooded. The damage to crops is very considerable. Several bridges have been carried away and many railroad washouts have occurred.

THE boiler of engine No. 496, New York Central & Hudson River Railroad, exploded Nov. 15 at Palatine Bridge, N. Y. The engine, which was hauling a stock train, had run from Rome to Palatine Bridge without taking water; the water in the boiler was very low and when cold water was pumped in, the explosion occurred. One man was killed and another injured.

A PORTION of the ironwork of the Union Elevated Railroad, now under construction in Flatbush avenue, Brooklyn, N. Y., together with the derrick used in its erection, weighing altogether about 250 tons, fell down on Nov. 16. The accident was said to be the result of careless work, two girders which had been put in place the previous night, just before the men quit work, not having been riveted to the other part of the structure, they were held in place by their own weight only, and when the derrick was moved forward to rest upon them and was being used to haul up a girder, they turned over and the derrick and ironwork fell into the street.

RUMOR has it that Mr. B. W. SPENCER, formerly of the Erie Railway, and FREDERICK A. POTTS, of the New York, Susquehanna & Western R. R., are interested in a bridge across the Hudson at New York. As reported, the scheme is for a cantilever bridge with maximum span of 780 ft. and 165 ft. headway; to cross from Steven's Point, in Hoboken, to somewhere near 42nd street. It is to carry all the railroads, "except the New York Central and West Shore," and will besides have wagon-ways, footways and a cable road system. The same report, however, says that no engineer has yet made plans, otherwise than to say it is feasible. The whole rumor practically amounts to nothing more than that the time is drawing very near when such a bridge must be seriously considered.

ACCORDING to the Berlin Bureau of Statistics, there are in the world the equivalent of 46,000,000 horse-power in steam engines, 3,000,000 being locomotives. Other than locomotives the engine power ranks as follows:—United States, 7,500,000; England, 7,000,000; Germany, 4,500,000; France, 3,000,000, and Austria, 1,500,000. Four-fifths of the steam engines now in operation are said to have been built within the last 25 years.

THE Board of Experts for the Brooklyn Bridge, which was disorganized by the resignation of Col. F. K. HAIN, General Manager of the Manhattan Elevated, on the ground of inability to give the necessary time, has been completed again by the appointment of WALTER KATTÉ, Chief Engineer of the New York Central and West Shore. Perhaps no man more thoroughly qualified by past experience to fill the void left by Col. HAIN's resignation could have been found in the city. The Board as reorganized consists of Col. JULIUS W. ADAMS of Brooklyn, JOSEPH CRAWFORD, Division Superintendent of the Pennsylvania Railroad, and Mr. KATTÉ. The latter was, at the urgent solicitation of Col. ADAMS, chosen as Chairman of the Board.

THE reorganized Board has already held one meeting, on Saturday afternoon last, when a new letter of instruction was given them correcting the objectionably narrow discretion which was opened to them by the first letter, as noted in our comments on "The Brooklyn Bridge Problem" in our issue of Nov. 5, and explicitly instructing them to consider and report on what was "absolutely the best system," without the least implication even of any limitation on their discretion in favor of individuals. Further meetings will be held on the day of this issue, and on each Saturday afternoon hereafter, until the labors of the Board are completed. The report of Terminal Committee of the Trustees, which now consists of Messrs. HOWELL and CLARKE only, Mr. MACDONALD being absent in Australia, will doubtless follow almost immediately, and thus for the first time there is definite prospect of careful, considerate and prompt action to finally settle in the best way this most important question.

THE Brooklyn Bridge Trustees have compromised the $100,000 suit of the National Cable Co. for alleged infringement of patents by paying $5,000 to the plaintiffs.

Launching the Torkham Bridge in India.

The launching of riveted girders, as practiced in India, has been little described, and the following detail, as abstracted from an article by Mr. OSCAR OLLENBACH in *The Indian Engineer*, may prove of interest to our readers, especially as the work was done under rather trying circumstances, though the spans were light:

The Torkham bridge carries the Hurnai-Bori road, a branch of the Dera Ghazi Khan-Peshin road, over the Meheob river, near the mouth of a narrow rift or *tangi* (the local appellation).

As the road had to cross over from one to the other of the precipitous and parallel faces of this rift, and at its lower end it was necessary that the bridge should be laid in a direction making a large angle with that of the road, the approaches were necessarily laid out in sharp curves.

The bridge is designed to carry a 10 ft. roadway on the upper booms of the girders. It consists of three spans of 16, 67½, and 20 ft. in the clear respectively. The center span consists of open braced girders, the others of rolled beams. The contractors are Messrs. RICHARDSON & CRUDDAS, of Bombay. The Meheob river is subject to high and violent floods, whose waters rush down with velocities occasionally exceeding 20 ft. per second. It is superfluous to remark that staging of any description could not possibly stand so formidable a rush; nor would it be safe to build up the girders in the river bed.

There only remained the second method, and here a difficulty presented itself in there being insufficient room for a single girder to be built up in line with the bridge. This could be obtained by cutting into the rocks, but only for the length of one girder. This necessitated the girder being supported at the outer end, when nearly half of it was drawn over the outermost support, *i. e.*, over the pier.

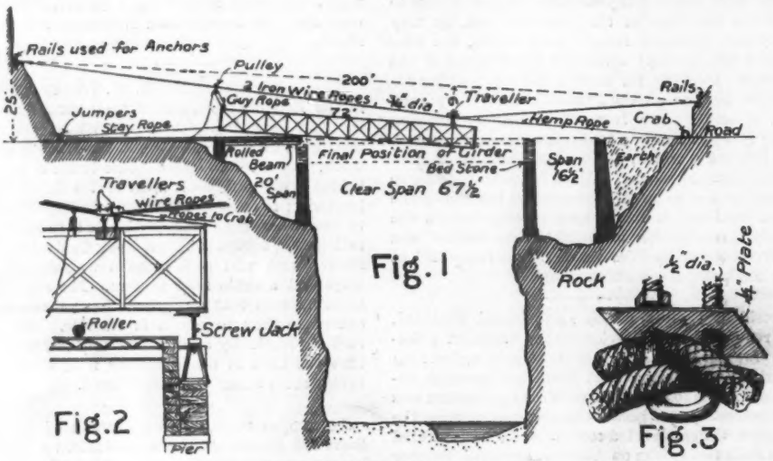
To effect this it was proposed to pass a wire rope across the span and, having the outer end of the girder attached to this rope, any support that would be required could thereby be given. The girders were to be built on the road level, as otherwise a large amount of rock cutting would be required, which is an expensive item here. The preliminaries being decided upon, the details were carried out in the following manner:

Two spots were chosen for the supports of the rope, one 25 ft. above the road level on the side where the girder was to be built; the other on the opposite side of the river at a distance of 200 ft. from the first, and at a height of 10 ft. above the road-level. On the higher side two pairs of rails were let into holes drilled into the rock at a distance of 5 ft. apart in a horizontal line. On the lower, a bunch of rails in the shape of an inverted cone was also imbedded in rock. The rails forming this cone were kept apart by means of a wooden plug and weights. One end of a ¾-in. diameter iron wire rope was then coiled round the two pairs of jumpers, and the extremity secured to a coil by means of clips. These clips are very simple. A piece of rod-iron, U-shaped, has a screw-thread cut on each of its arms. The ropes are passed within these arms, and a piece of flat iron then placed over the ropes and held down firmly by nuts. These work admirably.

One end of the wire rope being secured the other was drawn up by means of a differential pulley secured to a loop of hemp rope, which was practically untwisted and then wrapped on to the wire and to the bunch of rails with the aid of a chain.

In this way the wire rope could be drawn up to any requisite degree of tightness. The hemp loop never slipped and only once gave way when the strain exceeded five tons. Of course before being thus taken up a traveler and pulleys were passed on to the rope, so that the girder would be carried by them, and by them its weight would be transmitted to the rope. After this the free end of the rope was coiled round the bunch of rails and then drawn taut with the aid of pulleys and secured by clips.

In a similar manner a second rope was secured, care being taken that the two ropes should hang evenly. The versed sine of the curve formed was allowed to be 85 ft. When this was completed, the ropes were each tested with a weight of two tons, *i. e.*, the weight of half a girder. The result being deemed satisfactory, the launching was taken in hand. It should have been mentioned that the fitting and riveting of the girders went on simultaneously with the arrangements for launching. The second girder, for want of room, had to be built away from the first, as shown in sketch.



TORKHAM BRIDGE, INDIA.
Fig. 1.—Swinging Girder into place.
Fig. 2.—Method of Attachment of Traveller, etc.
Fig. 3.—Clips used for Securing Ropes.

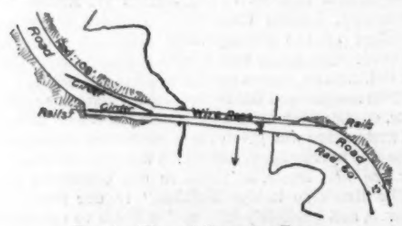


Fig. 4.—Plan of Carrying Ropes.

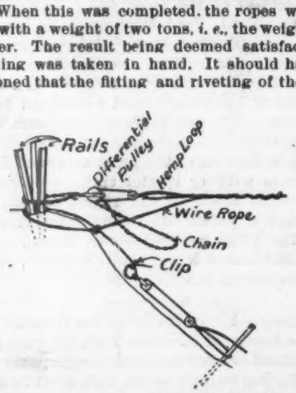


Fig. 5.—Method of Tightening Ropes.

The details of fitting up need hardly be mentioned here. Suffice it to say that a camber of .12 ft. was given for a girder of 72 ft. length, that is, a proportion of 1/6. I always filled up each rivet hole with the rivet which would eventually be closed in it, using as few nuts and bolts as possible. If this precaution be observed, there is less fear of the work being scamped by the riveters when your back is turned on them, as the rivets will, if properly heated and well hammered, fit evenly, and completely fill the holes. If not, they will be loose throughout, and will be easily detected with a stroke of a hand hammer.

The wedges were now removed and an olive wood roller placed under the center of the girder. The roller consisted of a solid cylinder of wood of diameter 6 ins., and length 2 ft. Olive wood was selected for this, as, when green, it is capable of offering great resistance to crushing. The roller was allowed to rest on a row of planks placed under the girder, so that the resistance due to friction in rolling the girder might be reduced to a minimum. The outer end of the girder was then lifted up by the aid of the screw-jack and the wire ropes drawn down as low as possible by ropes and pulleys. A chain was passed under the girder top boom and over the hooks of the travelers, and when the jack was lowered, the end of the girder was found to be supported by the ropes.

To prevent the chain cutting into the boom plates, blocks of soft wood were packed under the iron and between it and the chain. By the weight of the girder the chain was pressed into this wood, which was an advantage, as the chance of the chain slipping off it was thereby greatly reduced. A rope was then attached to the inner lower end of the girder and passed over a couple of jumpers let into the rock behind, in such a manner as to form a sort of figure 8. This rope was paid out a little at a time, and was used only after more than half the girder was launched. Its object was to prevent the girder going out with a run.

A second rope was attached to the upper boom at this end and then passed over pulleys, which hung on the wire rope. Its object was to steady the girder whilst rolling forward. A third rope was now passed through the travelers and across to the crab winch on the opposite bank. This completed the arrangements: and orders were given to commence hauling in the rope attached to the crab winch, which was drawn up and had to be subjected to a good strain before overcoming the inertia of the girder. When this was overcome, the girder ran forward briskly, at first a distance of 3 ft. but later on only 6 ins., *i. e.*, the pitch of the rivets on the bottom flange.

In this manner the girder was rolled till its further end was nearly over the small span. The roller was then taken away and a thin jumper substituted for it. The girder was then moved over the remaining few inches to the very extreme point to which it could go safely without dropping down beyond the pier. Blocks were built up under the girder and on the pier in a double row, one for the jack to rest on and the other for the girder. The jack was then wound up and the girder lifted thereby. The last plate was removed and the girder lowered 3 ft.

After this, the other end of the girder was lifted up a couple of feet, till the ropes above it became slack, the chain was then removed from off the travelers, and this end of the girder lowered to nearly the bed level, then traversed nearly into position. Afterwards the end first lowered was put nearly into position.

The second girder was now taken in hand. Being built apart from the ropes, it had first to be placed under them. This was accomplished by placing the girder on rollers and drawing forward till a part of it was brought under the ropes. It was then slung on to the ropes and drawn still further forward till the outer edge was nearly over the first pier. The rollers were then removed, and planks placed one upon another put under the girder in a direction somewhat transverse to it. Ropes and pulleys were attached to the lower boom and jumpers on the hillside, with their aid the girder was moved sideways, the planks sliding on one another. The rolling operation was again repeated, and the second girder was placed nearly in position.

The final position was attained by placing the girders again on jumpers as rollers resting on the bed stones and pushing forwards or backwards with levers. The cross-bracing was then fitted on as also the roadway plates on the top boom. The camber was finally measured, and found to be 0.10 ft., that is, a loss of only 0.02, which is very satisfactory.

Some Effects of Gould's Visit to England.

There is a panic in Amsterdam.

The City police force is being augmented

Chubb's patent locks are in strong demand.

The water companies have advanced their rates.

A provincial safe-maker advertises "Gould-proof safes."

The guard at the Bank of England has been doubled.

There is a strong and growing demand for Milner's safes.

Madame Tussaud is making an addition to the Chamber of Horrors.

The Queen's Jubilee presents will be withdrawn from public exhibition.

Guards are being established over the tracks of all the railways in England.

The cashiers and book-keepers of the London Banks are being armed with six-shooters.

The Safe Deposit Company's vaults are all full, and men are working day and night on new ones.

The Post Office authorities have asked for military aid to guard the telegraph wires, and the telegraph poles have been chained to the ground.

London *Financial News*.

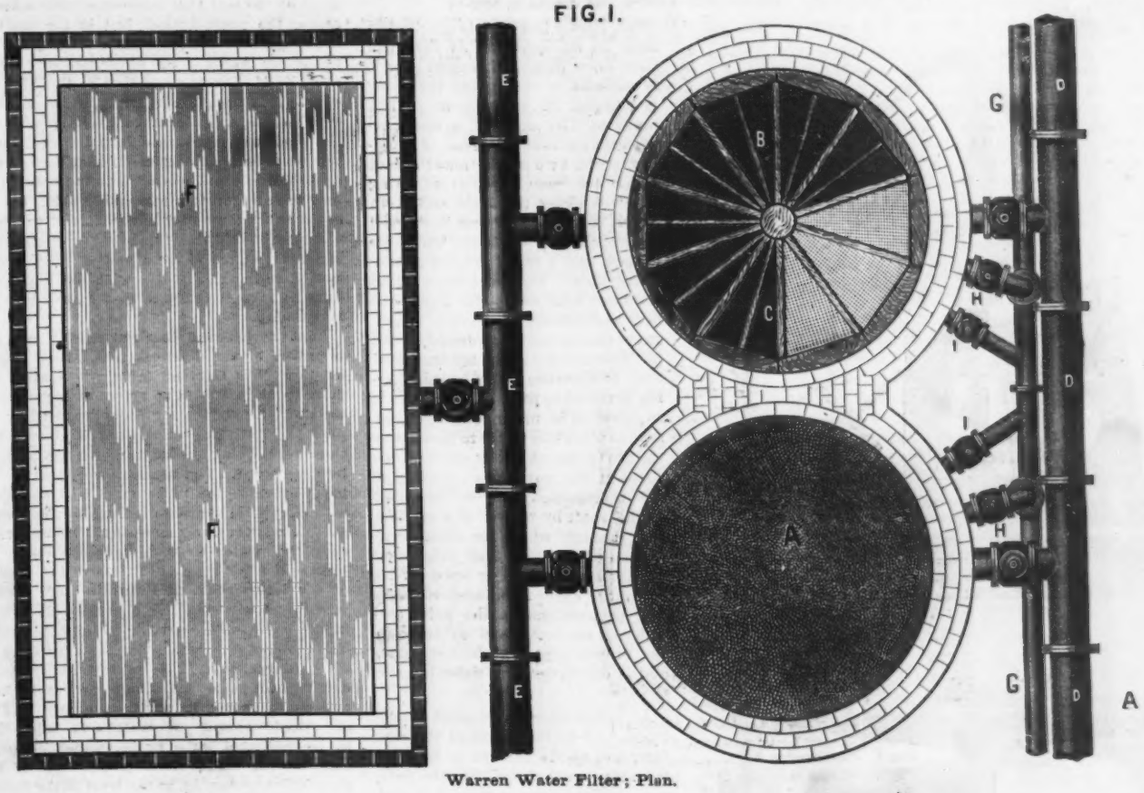
The Warren Water Filter.

The elimination of foreign matter from water intended for domestic or industrial use is one of the important problems of the day; and to accomplish this work rapidly and yet effectively is the aim of numerous inventors. Among the more recent and successful ventures of this kind is the Warren filter here illustrated and described.

The operation of the system is shown in the accompanying cuts. Figs. 1 and 2 show a plan and sectional elevation of the filters. Referring to the letters in Fig. 1, *A* shows the filter tank and bed, and *B* is the wooden grating in the same with a perforated copper cover *C*. *D* is the main supply pipe; *G*, the waste pipe to sewer, or sump; *H H* are the waste gates above the filter beds and *I I*, the waste gates to the space under the filter beds; *E* is the outlet for filtered water; and *F* is the storage tank. In Fig. 2 other letters are unfortunately used to designate similar parts, but the reader can readily correct for himself this discrepancy. The other parts shown on the sectional elevation are—*I*, the agitator, for slightly harrowing the surface of the filter bed; *K*, the agitator shaft; *L*, a sleeve with rack and pinion for raising and lowering the agitator, and *M*, the gear and pulleys for rotating the shaft.

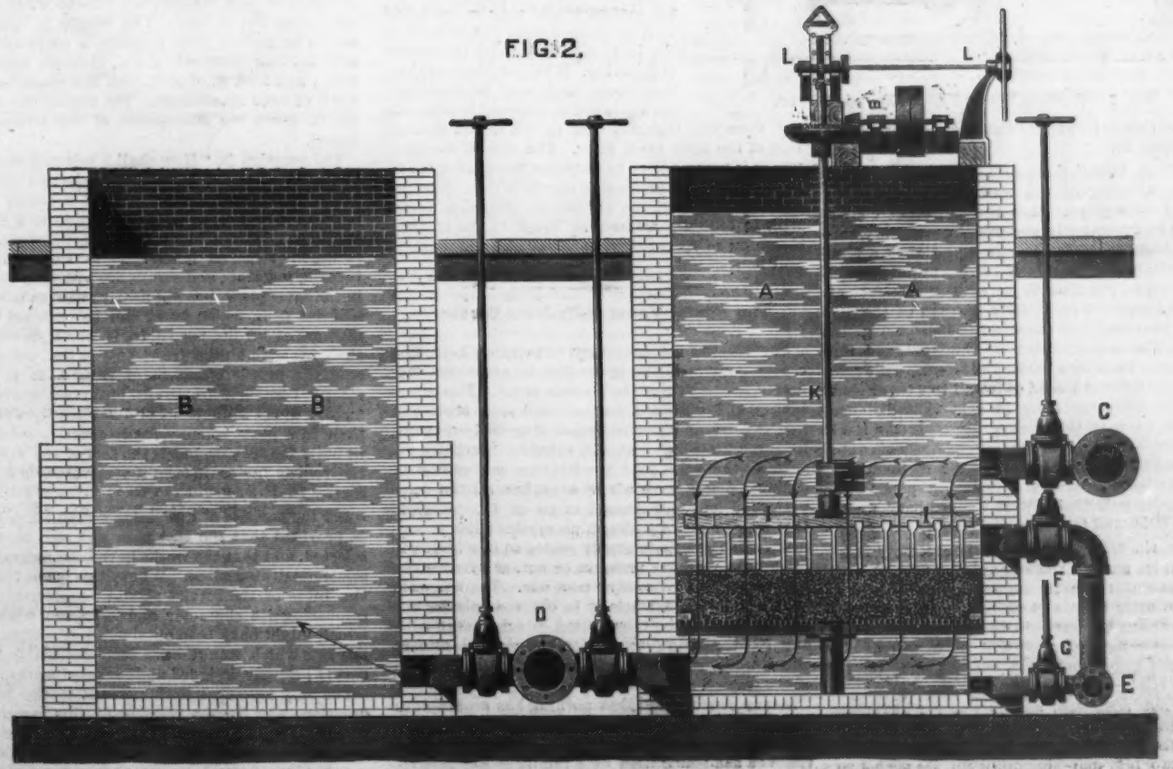
In practice, the more usual dimensions and operation are as follows:—The filter tank is 8 ft. in

FIG. 1.



Warren Water Filter; Plan.

FIG. 2.



Warren Water Filter; Longitudinal Section.

diameter, thus affording an area of about 50 sq. ft. in each tank. Near the bottom of this tank is a grating of wood covered with a plate of copper, with perforations fine enough to retain the grains of filtering material. On this plate rests a 15-in. bed of carefully selected and sifted gravel of uniform size throughout. The water passes from the supply pipe into the tank and down through this gravel

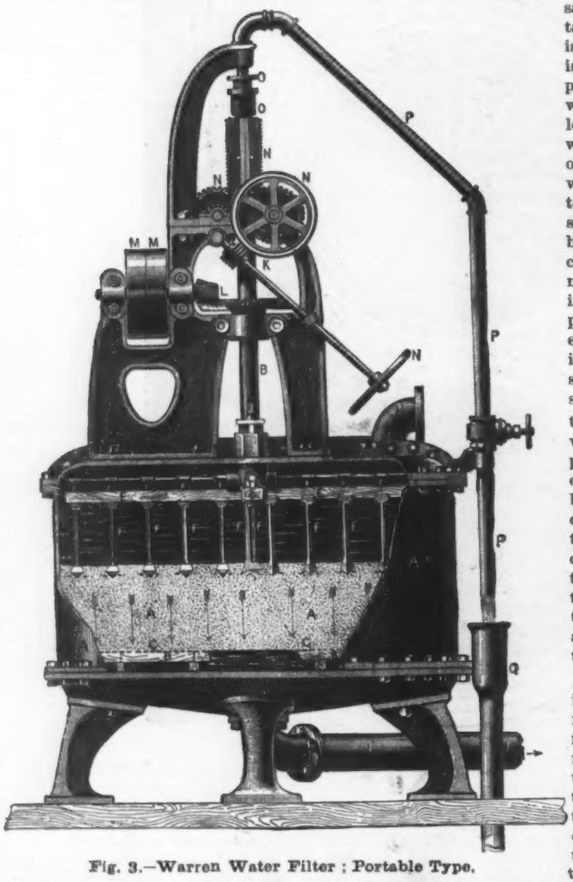


Fig. 3.—Warren Water Filter; Portable Type.

filter, and thence into the outlet pipe or reservoir, as the case may be.

The rate of filtration depends so much upon time and the character of the water that no definite amount can be given. Slow percolation of course gives the best results. In two years' use at the Cumberland Mills, in Maine, it was found that a flow through the bed at the rate of 1 ft. per minute would afford 1 cu. ft. per minute for each square foot of filter area, or 500,000 galls. daily for each of the size of filter proposed. At these mills 12,000,000 galls. daily are thus supplied and manipulated, and the filtering goes on as by a battery of filters. This rate implies that there is a head of from 1 to 2 ft., or that the supply from the river is kept that distance above the water in the storage tank. If the level falls below 2 ft. the filter is cleaned. This rate is sufficient for all the demands of a mill manufacturing the best qualities of printing paper and would render sufficiently pure the ordinary water supply of cities and towns.

To clean the filter bed, all that is necessary is to close the inlet gate on the supply pipe (Fig. 2), and to open the sluice gate in the waste pipe; this will empty the filter tank, and as soon as it reaches a level lower than the water in the storage tank, the filtered water in the latter will begin to boil up through the gravel and wash out and carry off to the sewer the entrapped sediment. As this action alone is not sufficient, as the water will break through in spots and leave parts practically untouched, the process is completed by bringing the agitator into play and ploughing up the gravel to any desired depth. This combined action effectually cleans the filter bed, and may consume from 5 to 10 minutes. The gates are then again manipulated, and the filtering goes on as before. The process of filtering may also be promoted by allowing the teeth of the agitator to scratch the surface whilst this operation is going on, as this will break the impervious film which has otherwise a tendency to form on the surface. These filters are actually in operation at the paper mills of S. D. WARREN & Co., at Cumberland Mills, Maine, and at the waterworks of Brunswick and Augusta, Me.

The portable filter, shown in Fig. 3, is exactly the same in its operation as the open tank filter described, except that it is enclosed at the top and the water is pumped in under more or less pressure. The agitator is the same with the addition, however, of a hollow shaft, from the lower end of which are branch pipes extending outward along the arms, and from which small pipes extend downward to the points of the teeth, which are shaped like a small double mouldboard plow. This encloses a small chamber with which the pipes connect and through the walls of which, in the face of the mouldboard, small perforations are made, too fine, however, to allow the grains of the filtering material to pass. As this filter is supposed to be under sufficient pressure to allow the water to pass above the top of the shaft by opening the valve in the waste pipe, this waste pipe is connected with the upper end of the shaft by means of a stuffing box, through which the short vertical end of this pipe may slide when the agitator is raised or lowered. A current of water is induced through the perforations in the point sections of the teeth, and so through the branch pipes and hollow shaft, and is discharged in sight outside the filter.

As before stated the deposit of sediment will be largely upon the surface, and as the current is induced from this point of the filter the sediment will be drawn off with it and the surface gravel may be subjected to a continuous cleansing without in the least interfering with the process of filtration. When occasion requires, this waste valve may be closed and the whole bed be cleansed in precisely the same way that has been shown in the description of the open tank filter. The size of the filter which is now ready to be put upon the market is 5 ft. in diameter thus presenting nearly 20 ft. of filtering surface, and with the automatic cleansing device will, in ordinary waters, be equal to the efficient cleansing of from 300,000 to 500,000 galls. in twenty-four hours.

The Rental Value of Hydrant Service.*

For reasons not necessary to mention here, I recently became much interested in questions suggested by the title of the present paper. The examination of engineering journals and such books as I had at hand, and inquiries made of several engineers, gave me little light on the subject. Statistics regarding the price paid per hydrant per annum in different places were not lacking, but all the comparisons I had seen seemed to go on the principle that a hydrant is a hydrant, no matter what it protects, what it costs to supply water to it, whether it has a good working pressure or not, or whether the hydrant itself is a good or poor one. The amounts per hydrant vary materially in different places, but I could not see that they varied in accordance with any fixed relation to any of the various factors which would seem to have a bearing upon the value of the service.

It may be truly said that nothing has an absolute value. It would be impossible to prove that five dollars or any other sum, is, in any place, the exact value of the water used by a family of five persons during a year, but in this and all other cases some price must be fixed. In case of food, clothing, etc., the supply and demand regulate the prices, but as water companies generally act under charters giving them practically exclusive rights, the case is very different. There is substantially no competition and no regulation. The price of water for domestic or manufacturing purposes is to some extent regulated by the fact that moderate prices materially increase the consumption; but in the matter of hydrant service the town must either pay the price and accept the terms of the water company, or refuse to avail itself of such protection as the company may offer. It is therefore in many, if not most cases, in small towns, a matter of comparative shrewdness of the officials on either side as to the price paid and service rendered. One charter I have seen, said to be a characteristic one, states that any person in the town may have water at a reasonable price, but does not say that the town may have water at any price.

It may be said that this is not an engineering matter, but it seems to me a matter worthy the attention of engineers, and it is with the hope of getting some light on the subject that I have brought it up here to-day.

That the question does not readily care for itself is proved by the deadlock which now exists in at least one New England town, where after a year or more spent in efforts to arrive at some settlement, the provisions of the contracts proposed by the company and town respectively are as given below, only those parts being quoted in which the principal differences occur. The contract proposed by the company provides for "7,000 ft. of 6-in. and 3,200 ft. of 4-in. pipe," "53 hydrants for use by the town," and states that "the water company will furnish an ample supply of water to such hydrants under a static head of not less than 110 ft. above the present level of the intersection of Franklin and Washington streets and will establish a permanent bench mark in the company's reservoir to indicate said level." The contract proposed by the town provides for "10,200 ft. of 6-in. pipe," "53 improved anti-freezing hydrants, with suitable drainage, for use by the town," and states that "the water company will furnish an ample supply of water to said hydrants, to be indicated by a proper water gauge, which shall at all times show a pressure of not less than 50 lbs. per sq. in. at the level of the intersection of Franklin and Washington streets when the hydrants are not in use." The supply in the above case is by gravity from a reservoir covering 5 acres and holding 16,000,000 galls., through 9,000 ft. of 12-in., and 9,000 ft. of 10-in. pipe to a manufacturing town of 4,000 inhabitants. The top of the dam is 124 ft. above the intersection of the streets mentioned.

The question is, "How shall a fair rate be arrived at?", and all the facts bearing on the case should be taken into consideration. It is certainly worth more to give equally good protection to a place of 100,000 people than to a place of 50,000 people, but is it worth twice as much? It is worth more to furnish, maintain and supply 200 hydrants than 100, in the same place, but not nearly twice as much. A hydrant from which water can be obtained with a pressure of 100 lbs. per sq. in. is worth much more than one with a pressure of only 50 lbs., but is pressure the proper standard of value? It is worth more to furnish a fire service in a place where satisfactory works cannot be built for less than $300,000, than in a place where equally effective works can be built for $100,000, but is the cost of the works the controlling factor in the rental value of hydrant service?

For the purpose of discussion I shall claim that it is, provided that the best plan and site have been selected, and that the works have been properly and economically executed. Where this is not the case, the value of the service should be ascertained by comparing its character and efficiency with that which might have been obtained, and scaling down the rate which would have been desired from the cost of properly designed and executed works.

The only answer I have received to the leading question, was from a member of this association, who said: "The price of fire service should be a fair interest on the additional cost of the plant on account of such service, plus cost of repairs to hydrants and connections." This sounds well, but why not say that the price of water for domestic and manufacturing uses should be such that it will pay a fair interest on the additional cost of the plant on account of such use (assuming that works

* A paper by C. E. CHANDLER, C. E., of Norwich, Conn., read at the Fall meeting of the Connecticut Association of Civil Engineers and Surveyors, Hartford, Conn. Nov. 9.

sufficient for fire purposes would have to be built in any case), plus the cost of maintaining service pipes, collecting water rents, etc. In other words, is one service the main thing and the other a sort of addition to be furnished at its mere extra cost, and if so, which is which?

For the purpose of argument I suggest that each should pay the expenses peculiar to itself and that the common expense be divided between them on some basis, but the difficulty is to determine what the basis shall be. Fire service calls for very little water. It is estimated that the water annually used for fire purposes in Boston is only about $\frac{1}{10}$ of the daily consumption, so that the expense of storage reservoirs, auxiliary supplies and all expenses due to producing a large amount of water are chargeable to consumers. On the other hand large main pipes, extra pump power and all extra expenses incurred in creating a pressure greater than that sufficient for the domestic supply, are chargeable to fire service. Service pipes and their maintenance, collecting water rates, etc., are chargeable to consumers, while hydrants, hydrant repairs and connections are chargeable to the fire service. I therefore suggest, with much hesitation, that the common expense be divided in the same ratio as it shall be proved that the peculiar expenses bear to one another. Thus the company that judiciously expends the most money in perfecting its fire service will receive the greatest returns from the public.

I have not had the necessary data at hand to determine how the rate thus ascertained would compare with actual rates in any place, but I believe that if the compensation paid by towns to water companies for fire service was figured on some such basis, it would result in much more efficient fire service. Take for instance the town above mentioned, with a population of 4,000, which is liable to be doubled in the 20 years which the contract has to run. Then the consumption for 8,000 people using only 50 galls. per day each, would be 400,000 galls. per day, one tenth of which is liable to be used in an hour, or 667 galls. per minute, which in 9,000 ft. of 12-in. main will reduce the head 12.6 ft., or in 9,000 ft. of 10-in. pipe will reduce it 29.9 ft., a total reduction of 42.5 ft., making the "static head" of 110 ft. proposed by the company a practical head of 67.5 ft. or 29.34 lbs. per sq. in., a very inefficient fire pressure, while the friction in a 16-in. main with the same flow would be less than 3 lbs. per in. When the velocity produced by the additional flow required at a fire is considered, the contrast is much greater. A tank or distributing reservoir might answer the same purpose as a larger pipe.

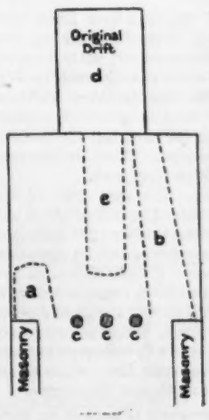
There is one point in connection with hydrant service to which I wish to call special attention. It will be noticed that the contracts proposed by the water company and the town differ, not as to the price of the goods, but as to their quality. The company agrees to maintain the water in the reservoir at a certain height, but guarantees no pressure whatever in the street mains of the place. The town, on the other hand, insists that a certain pressure must be maintained in the main pipe at a central point. Now the questions are; 1st. With a reservoir 110 ft. high above said central point, and 9,000 ft. of 12-in., and 9,000 ft. of 10-in. pipe leading thereto, and 8,000 people to supply with water; what pressure can the company expect to maintain in the pipes at said point at the end of 20 years? 2nd. With the same reservoir and distance 18,000 ft. what pressure ought the company to have constructed its works to produce? I will venture to state my opinion that the answer to the former question is less than 30 lbs. and that the latter ought to be more than 40 lbs.

We come again to the main question, "How shall we ascertain the true rental value of hydrant service?"

[NOTE.—In the brief discussion of this paper, the question of the relative value of single and double nozzle hydrants was brought up, Mr. AYRES stating that some town officials demanded the latter form, under the impression that they were getting twice as much water for fire purposes, without regard to the size of the supply pipe. The general opinion was in accordance with the views expressed by Mr. BISHOP and Mr. MCKENZIE that while double-nozzle hydrants on pipes of sufficient size would supply more water to any neighboring fire, yet for general fire purposes single nozzle hydrants, placed at more frequent intervals, would give greater efficiency, and would also give a greater pressure, as the loss of pressure by friction through long lines of hose is far greater than in the mains, as shown conclusively by experiments made some time ago by Mr. MCKENZIE. The general discussion of the subject was postponed till the next meeting.—ED.]

New Croton Aqueduct. The Accident at South Heading Shaft 17.

In our issue of Aug. 13 we described and illustrated the method of building one of the sections (south heading of shaft 17) of the new Croton aqueduct, which passes through loose material. In executing this plan a drift 4 or 5 ft. in height by 9 ft. in width was extended in advance of the main full-sized section. This drift was parallel with the tunnel, but its floor was on a level with the top of the crown. When the drift had been finished a sufficient distance, three crown bars—white oak sticks from 16 to 22 in. thick at the butt—were placed so that their rear ends rested on the completed masonry, their forward ends being supported upon timbers which ultimately formed the face of the heading. From the crown bars as a foundation the excavation was carried down each side, a little at a time; other longitudinal bars were inserted, and in the spaces between the bars were driven narrow strips to form a sheathing to prevent the entrance of earth.



On Sept. 9 when the section had been completed and cleaned out ready for the masons, the two sides and face caved in. The peculiarity of the accident was the fact that the movement came absolutely without warning, the three parts giving way at the same instant. This blow-like effect was probably caused by the movement of material in a pocket above the chamber, the equilibrium of the earth immediately surrounding the section being thereby destroyed, and the whole weight of the mass being brought upon the timbering which of course yielded, and yielded as a whole. It is not known whether the blow was caused by the roof of the pocket (the presence of a pocket is known since there is no indication of a cave at the surface of the ground) dropping, or by a large mass sliding along a shelving rock. The latter supposition has some foundation, as pieces of rock of considerable size, and of the same nature as that which the work had but just passed through, were found at the edge of the finished masonry. The section that caved in was 19 ft. in length, and the drift extended about 15 ft. beyond this.

In the foregoing we have mentioned the principal characteristics of the work in order that the following may be the more readily understood.

Work was resumed after the ground had been allowed to settle about a month. The top of the wedge-shaped deposit which had flowed into the aqueduct was removed to a level about 6 ft. below the crown. The crown bars, *c c c* were found leaning against the brickwork in a nearly upright position. It was apparent that their forward ends, having been deprived of all support, had fallen to the bottom of the section. After the spaces between the bars had been calked with hay and poling strips driven to hold back all unprotected earth a drift was started at the eastern side of the tunnel at *a*. At a few feet from the masonry a large rock was encountered. This drift was then abandoned for the time and a second one begun at *b*, the opposite side of the tunnel. The second drift was driven at an upward inclination to reach the level of the top of the tunnel, and in a line toward the center of the work. 20 ft. from the masonry the original drift *d*, which was opened in advance of the section, was met. This drift was found uninjured in every respect, which circumstance would indicate that the disturbance causing the accident came from the opposite direction, or above the finished work. If this supposition be correct there is now a pocket between the completed masonry and the surface, and not over the caved-in section. The floor of this pocket is formed by a sloping rock extending in the direction, and probably to within a few feet, of the end of the masonry. During the building of this section, and the two just preceding it, much loose earth flowed into the tunnel, and a vacancy was therefore made near the exterior of the sections. The pocket then formed is now filled up, and the present pocket is located further from the work. The result of any shock that might be transmitted through the intervening loose earth to any future timbering by the sudden filling of this pocket cannot, of course, be even conjectured. It may be at such a distance away, that the jar would not be perceived, especially as the ground has had time to assume a comparatively compact condition.

Upon reaching the old drift a third drift *c* was started toward the tunnel already completed. This drift is above the outside of the crown, and is designed to receive the center crown bar, which will be supported as the other was, its rear end on the brickwork, and its forward end on timbering. The sides will then be dug out to admit the side bars, when the section will be built as was the other. One important change will be made in the plan. The length of the sections will be much reduced, and the masonry laid whenever possible even though the rings should measure no more than 4 or 5 ft. This will reduce the surface of earth to be timbered, will render the work safer, and in the event of another cave would destroy but a small part of the work.

The accident clearly brought out the character of the masonry, which was damaged only to the extent of a few cracks, none of which appears far from the end.

The accompanying plan view is not made to scale, but is merely intended to show the state of the work in the heading at the time of the accident and now.

The Physique of Americans.

Mr. EDWARD ATKINSON, the statistician of Boston, answers in *Science* a charge made abroad that the white man is deteriorating in size, weight and condition in the United States. To obtain data for his deductions, Mr. ATKINSON applied to a number of prominent clothiers in Boston, Chicago and elsewhere, firms which make up suits by the thousands for all parts of the country. In answer to this rather novel application he was told that experience proved that in any given thousand of suits the average measurement was as follows:—Chest measure, 38 ins.; waist, 33½ ins.; length of leg inside, 32½ ins.; average height ranging from 5 ft. 8¼ ins. to 5 ft. 9 ins. in New England, up to 5 ft. 10 ins. for the average in the South and West. The average weight probably lies between 155 to 160 lbs.

Different sections vary in their requirements and the residents of towns usually average less in measurements than those living in the country. For the South the average chest measure is 35 to 40 ins., with a relatively small waist; in the West and North the chest measure is 37 to 42 ins., with 33 to 40 ins. around the waist. A Texan correspondent gave 38 ins. as the average for the chest; 33 to 34 ins. for the waist, and an average height of 5 ft. 10 ins. A Detroit correspondent notes that in supplying clothing he finds that Germans need large waists and short legs; the French, small waists and long legs; the Americans, small waists and long legs.

Mr. ATKINSON concludes that the American is decidedly gaining in size and weight, in spite of "the frying-pan, dyspeptic bread and pale pie," and says he expects better things yet when the American woman has learned how to cook.

IRON BRICK PAVING STONES.—Paving blocks called iron brick are now being introduced by LOUIS JOCHUM, of Ottweiler, near Saarbrucken, Germany. This brick is made by mixing equal parts of finely ground red argillaceous slate and finely ground clay, and adding 5 per cent. of iron ore. This mixture is moistened with a solution of 25 per cent. sulphate of iron, to which fine iron ore is added until it shows a consistency of 38° Baume. It is then formed in a press, dried, dipped once more in a nearly concentrated solution of sulphate of iron and finely ground iron ore, and is baked in an oven for 48 hours in an oxidizing flame and 24 hours in a reducing flame. The German government testing laboratory for building materials has reported favorably on this brick.

The Water-Works of Kansas City.

BY G. W. PEARSONS, CHF. ENG. NATIONAL W. W. CO.

Continued from page 346.

The settling basins as first built, had a capacity of about 8,000,000 galls. the shape, governed by the railroad and Turkey creek, is irregular—mathematically speaking a truncated powder horn—no puddle was used in this or any subsequent work. The excavation is distributed in the embankments so as to place the most retentive earth inside, the aim being to have nowhere less than 12 ft. of good embankment next the water; the whole bank is carried up together in level 6 in. layers, each layer dragged and rolled with a grooved roller. The dragging by pulverizing the soil very thoroughly, seems to be as important as the rolling. The banks had a slope of 1½ to 1, in and out; the bottom of the first basins was 9 in. of concrete in two layers on the natural earth. This was in places sandy, and showed considerable leakage, which, however, became tight by the filling of the pores of the concrete with silt. Subsequent work has from 18 to 24 in. of clay, spread, dragged and rolled, as in the banks, and with less concrete. This has proved good. The outlet is 15-in. iron pipe under the banks, continued to Turkey creek with tile.

The bottom slopes of the basins built under the supposition that the amount of sediment was less than it proved to be, were from 1½ to 3 per cent.; this gives too much labor in removing sediment. Subsequent work has a minimum of 3 per cent. The same supposition as regarded quantity of sediment determined the writer to adopt a system of continuous subsidence. On the statement of Mr. B. HOLLY, that a regular current of 1 ft. per minute made no perceptible difference in the time required for subsidence, the basin was built with a central wall extending about four fifths of its length, the water entering on one side and passing slowly around the central wall to its exit on the other. The outlet to the clear water well, from which the high service pumps take water, is guarded with a crib of 2 in. plank, filled with fine broken stone; this, having an area of the whole end of that side of the basin, has proved always reliable and efficient as a strainer. The advantage of this arrangement is that the water can be kept at a uniform height, the low service pumps keeping the supply good for the high service; the disadvantage is that the basin must be wholly disused for cleaning: at such times the supply was drawn from the upper reservoir.

THE plan worked well until the supply reached about 2,500,000 galls. per day, then it was found that no provision having been made for controlling the water flow,—a current set up in the basins which carried the incoming water around to the outlet in much less time than the movement of the whole mass; a wooden partition was carried from the end of the central wall to the end of the basin, so arranged that the overflow of the first part of the basin descended in a long thin sheet to near the bottom of the other part of the basin; this was of immediate and important benefit, showing the value of controlling and equalizing the current. It being necessary to enlarge the basin, an addition was made by extending the outer walls, making a total capacity of about nineteen millions of gallons, the success of the continuous subsidence determined it for the new work, the inner walls being made heavier so as to allow any of the basins to be cleaned without emptying the rest. The concrete of the bottom was extended up the sides as far as considered safe from frost; above this the basins were covered with brick on edge; the upper reservoir with stone.

Ice freezing to this slope displaced the pavement in places; grasses and weeds took root in the crevices, and, worst of all, the ground behind became a burrowing place for crawfish, the latter showing their work by creating seepage through the banks. The pavement above the concrete was therefore removed, and a stone wall substituted. This has proved good and has been repeated in subsequent work.

The upper reservoir is a single basin, its use being practically that of a great stand pipe, keeping gravity pressure on the lower town and furnishing water for fires, as will be noted in account of machinery. It has a depth of 22 ft., and a capacity of about 9,000,000 galls.; water level of surface 932 ft. above low water. The inlet pipe for this was carried under the bank through a tunnel lined with concrete and brick; a well was built at each pipe joint and the spaces rammed full of puddle, a difficult job to make tight, and one which has not been repeated.

The Pipe Bridges.—One of these, over Turkey creek, is of 20-in. flanged pipe, the end having saddle and lugs cast upon them for the wrought-iron chords and as support over the opening lift in the masonry below it, the other line of common lead jointed pipe of the same diameter is suspended below it.

Another bridge over Turkey creek is of 30-in. wrought-iron, with bowl ends for the reception of the cast-iron pipe, the bowl ends are of cast-iron and have saddles cast upon them for their support on the piers; the pipe is in three parts joined by cast-iron flanges; the truss of gas pipe connected by joints similar to those used by the Phœnixville Bridge Co.

The creek is underrun in two other places by inverted syphons of wrought-iron, secured at the banks where they join the cast-iron pipe and the bed of the stream filled in with rip-rap to prevent wash.

Two other bridges of wrought-iron have been built by the Phœnixville Bridge Co. for the new work. One is over the Kansas river, 425 ft. in three spans, one similar span over Jersey creek in Wyandotte; these are built like ordinary highway bridges, except that they have longitudinal girders between the cross girders for carrying the wooden floor for the support of the pipe. These are intended to be able to carry three 36-in lines each.

First Pumping Station.—The flow line of the upper reservoir was determined by ordinance as not less than 175 ft. above datum; this was not sufficient to give flow into the upper town, and an elevation near the works giving more, it was chosen as the best available, and the machinery constructed with reference to it. Its elevation (232 ft.) gave a good gravity supply to lower town, but upper town required direct pumping; overflow by safety valve from the high pressure to the gravity line serves as an easement to the irregular motion of the pumps.

In its turn the upper reservoir is used as an auxiliary to their power for fire service. By changing a hydraulic valve at the works they take their supply from this instead of the lower, having the same effect as placing the pumps at the greater elevation, less friction in the mains.

This change is effected in about 30 seconds from the time of receiving the alarm. By this means the added power required for fire service is kept stored in the upper reservoir. The steam power required being little, if any, greater than for ordinary service, and the instant ability to respond to the call, assured as it could not be by any device for quick steaming. How effective it is, is shown by a quotation from the report of the Chief of the Fire Department for 1884.

"If there are any better works; any better system of works; any works giving better satisfaction to the Fire Department; any works kept in better order, or better managed in any part of the country, I would travel 1,000 miles to see what they have got and how they do it."

The ordinary pressure in lower town is 90 lbs. per sq. in.; this is generally sufficient for fire services but is raised on call to 130 or more. In upper town the regular service requires 130 lbs. pressure at the pumps, increased to 170 or more for fire service as may be required by its location and elevation. The pipe systems in upper and lower towns are separate, connected only at the works.

It is a question to what extent the system of direct pumping, combining domestic supply with fire protection without the use of steamers, can be used. As far as these works are concerned, supplying the combined cities in Missouri and Kansas, with a very difficult topography, and an aggregate population of nearly 200,000, the practicable limit does not yet appear.

The machinery to do this work requires special adaptation; the constant and sudden variations in supply, together with calls for pressure for fire protection, requires larger surplus power, and a minimum of inertia in the moving parts. The first engine is a Holly quadruplex, four steam cylinders 22 in. bore, by 30 stroke, standing at an angle of 45° with the horizon, on a frame carrying the crank shaft at its top; the cranks are placed 125° apart; the pumps are double acting, driven by extensions of the piston rods; their bore is 10⅛ in. The engines are compounded by using one as high pressure, and the other taking its exhaust; or they can be used with direct steam in all. The steam valves are slide with poppet valve cut-off on top, the latter controlled by the water pressure regulator, which varies the drop of the poppet by water pressure. This engine, standing over the syphon well, drives two deep well pumps by gears; these are 15⅛ in. bore by 30 in. stroke, double acting pistons. Since the introduction of PEARSONS' deep well pump they have been used only as a reserve; yet condensers are used with all the engines at this station.

A small quadruplex pump of about 1,000,000 galls. daily capacity, driven by a separate engine, was added for the early use of the works, and is still in occasional use; the engine has also been attached to PEARSONS' deep well pumps, which, like the others, are driven by gears. This pump has two double acting plungers, 21 in. diameter by 34 in. stroke, and was built with special reference to pumping muddy water. It has run seven years with only one breakage, the forcing out of the plunger-box bottom by accumulation of sand, disabling one side of the pump for two days. Aside from this it has not had a dollar of repair since it started, and the wooden gear wheel, carrying the pumps, shows scarcely any wear, although the pump is in constant operation day and night.

An incidental peculiarity of the engine driving these pumps is worthy of notice. The air pumps, having the slower motion of the water pumps, give only one-thirteenth of the volume of the steam cylinder, which, when both pumps are attached, requires from one-half to two thirds stroke of steam. Notwithstanding this small proportion, the vacuum is as good as in the other engines, and no air pumps on the works have been so uniformly reliable, or had so little repair.

The last engine is like the first, except in size, the cylinders being 27 × 30 ins., the pumps 11 × 33 ins., the added size of the cylinders is to give ability to compound the engine while taking water from the lower reservoir for fire service.

A Gaskill engine of 3,000,000 galls. daily capacity has since been added. This has been so fully described in technical papers as to need none here. All the machinery is intended for service in either upper or lower town, and is correspondingly complicated as regards its pipe connections; the combined capacity of the pumps at this station, for fire service, is 14,000,000 of galls. per day. There are eight boilers 5½ by 16 ft. tubular, with ordinary setting.

(TO BE CONTINUED.)

The Report of Chief Engineer Melville.

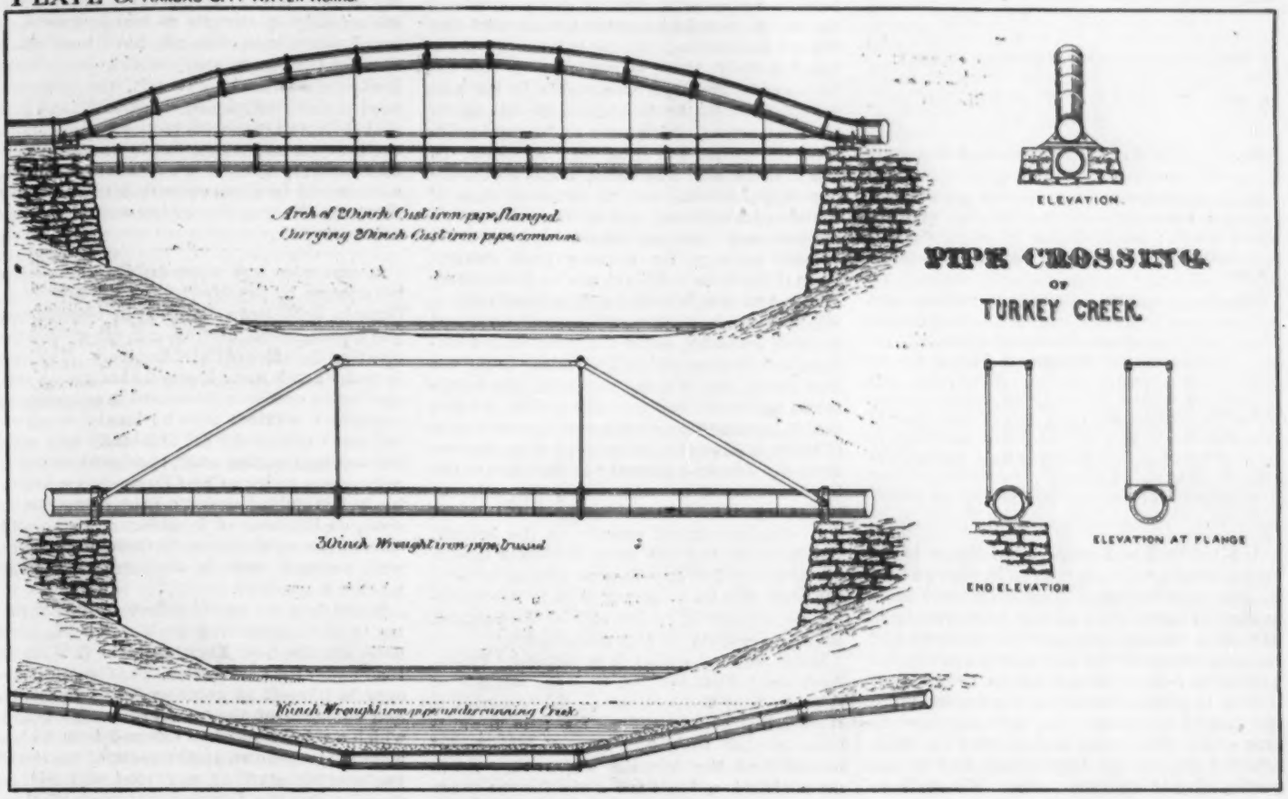
Chief Engineer MELVILLE, of the Bureau of Steam Engineering of the Navy Department, proves the wisdom of putting a live man at the head of this department by making one of the most sensible reports issued from it for a long time.

He first overhauls the present condition of the mechanical department of our navy yards, and recommends complete hydraulic boiler-making plants; a more economical arrangement of machine tools and shops, and especially the better distribution of steam by having one main boiler plant, with underground pipes, instead of the present wasteful method of having boilers for each shop. He suggests testing machines of the largest size for proving parts actually intended for use.

Mr. MELVILLE deprecates the present attempt, at the Naval Academy, to make the graduates Jacks-of-all-trades, and says this system will not produce the engineer officers wanted. He recommends that at the end of the second year the cadets be divided into midshipmen and cadet engineers, and that each class be especially trained for its duties. He also calls attention to the nonsensical feature of engineer officers standing watch over "a mass of cold iron" when their machinery is not running. He concludes as follows:

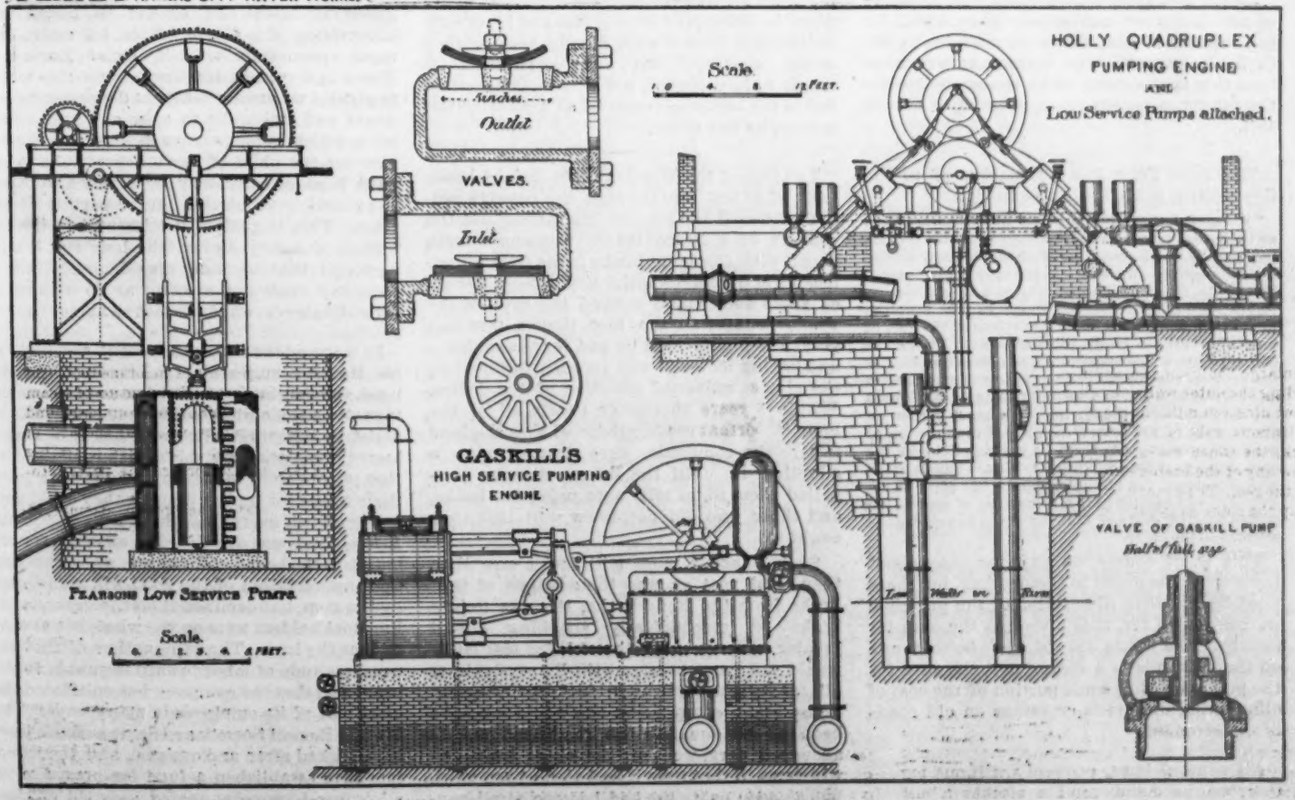
"There is too much dilettanteism in the navy. Many officers pay a great deal more attention to the specialties of others than they do to their own, with the result that they become proficient in neither. Four bureaus furnish steam machinery to ships, while the officers of only one bureau are specially educated and trained to the design and manipulation of machinery. In the interest of economy, harmony, and efficiency, this amateur engineering should be stopped at once, and all machinery be placed under the care of the engineers, while the other officers can find plenty to do in the wide fields of their own professions."

PLATE 3. KANSAS CITY WATER WORKS.



Kansas City Water-Works; Pipe Crossings.

PLATE 4. KANSAS CITY WATER WORKS.



Kansas City Water-Works; Pumping Engines.

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D. McN. STAUFFER. A. M. WELLINGTON.
EDITORS.

GEO. H. FROST, - - - BUSINESS MANAGER.

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A PROMINENT and responsible South American engineer writes us that he has been asked to take a concession of some magnitude for a system of tramways and that he desires to be placed in communication with engineers and manufacturers of the new systems of electric and cable plant. While we do not feel at liberty to publicly refer to the matter more specifically we believe this to be an opportunity which should not be neglected by those referred to, and as the fairest way to all parties give this public notice. We shall be pleased to communicate his address to all who may inquire for it.

IN our last article upon the proper tamping of drill-holes we incidentally gave credit for the reamer patent, there referred to, to Mr. C. L. KALMBACH. Mr. KALMBACH writes us that this is incorrect, as he is responsible for the air space patent alone, granted to him in 1874.

THE New York *Times* remarks, as to the Connecticut grade crossing question:

"We notice that ENGINEERING NEWS characterizes as preposterous our recent statement that the burden imposed by this law on 'some of the sparsely-settled towns is heavy.' We may cite the case of the town of Stratford. We are informed that at a recent hearing before the Railroad Commissioners in that town the New Haven Company's engineer estimated the cost of separating grades in the town at $30,000. By law the Commissioners are empowered to assess one-half of the cost on the town. But the entire amount raised annually by taxation in Stratford is only $16,000. Would not the doubling of the tax impose a heavy burden on the farmers of the town? Would not the exaction of such an amount from them be contemptible on the part of this wealthy corporation? We are unable to see why that town, for example, should in equity be required to pay one cent for a separation of grades, except in constructing new highways from one side of the railroad to the other."

This is, of course, an extreme case, about the worst to be found in Connecticut, but there need be no better illustration of the principle we contended for, that although the case for throwing the whole cost of such betterments on the railroads is a strong one, the case for the public bearing some portion of the cost of eliminating old grade crossings on old roads is still stronger.

All general laws, probably without exception, bear hard and even inequitably in individual cases. Against this instance of a poor town and rich road there are to be found, even in Connecticut, instances of poor roads and rich towns which they have largely helped to build up. In the country at large they are numbered by hundreds. But is there to be one law for the poor and another for the rich? The *Times* knows better. Again, barring this argument entirely, there is not even in this extreme case, anything inequitable in the present status. In the first place, the average of all assessments, which have so far been made upon the towns, has been only one-fifth. In this extreme case it probably would not exceed one-tenth, leaving the tremendous sum of $3,000 to $6,000 to be paid by the town for an improvement costing $30,000 and incurred chiefly to save its citizens from danger. Even if the town paid half, and so *for one year* doubled its tax, it is but a single payment; it would certainly add something to the assessed value of property, and if the town valued personal safety at anything it certainly could not lose much, even if it did not gain. Its exceptional bad luck doubtless arises from the fact that it is a small poor town with a great length of track in it, and little territory at a distance from it. The true inequity is that part of the burden cannot be distributed to adjacent towns, near to but not touching the track, and sharing almost equally in the benefit. But it needs but the most moderate intelligence to see that any general arrangement of the kind, if it be so arranged as in *no* case to bear at all hardly on one side of the bargain, must of necessity be very one sided.

Moreover, a bargain is a bargain. Therefore, we cannot but feel that the attitude of the people of Connecticut on this question is thoroughly contemptible. Its true inwardness is, that they find from the course of events that the bargain which they made themselves is not as hard a one for the other side as they might have made it. They are, therefore, disposed to abuse their exclusive power in the matter by cancelling it and making a harder one for the other side. It would never be attempted to play fast and loose with individuals in this way, merely because they were "wealthy," but with corporations it seems to be different, not only in Connecticut but in the editorial rooms of so generally fair a paper as the *Times*.

THE trip of the Westinghouse freight brake train of 50 box cars through the country cannot but recall the similar trip throughout the country of a Pennsylvania passenger train fitted with the same brake in its first imperfect form (non-automatic) now almost a score of years ago, which opened the eyes of the whole country to the fact that a new and great safeguard could be had for the asking—and paying for—and was speedily followed by the almost universal adoption of the device. Within 5 years thereafter nearly all of the more important roads outside of New England (where the companies were strangely slow in adopting it, until the Revere disaster compelled them to, in 1871) were using the brake, and those who did not, knew well that they ought to.

Such changes move still faster now than then, and vast as was the advance of that brake from the hand-brake, the new freight brake is, mechanically speaking, a still greater advance upon the old, for the latter would not have been practically available at all for freight service; in fact, the Westinghouse brake of two years ago would not have been at all equal to the requirements. It answered very well on the short trains on which up to that time it had alone been used, but as soon as its use had become at all general, serious troubles would have arisen from a cause unsuspected before the first Burlington tests, the shocks at the rear of the train due to the slow application on long trains. This has been completely eliminated, so that the brakes go on as fast as sound travels, taking only 1½ seconds to travel through 50 cars. Other improvements have been made to make the brakes apply more quickly in the brake-cylinder. As a result, the supposed need of electricity is dispensed with, and now that close and strong couplers are also coming in, there seems nothing left to wait for except inclination to act. It is well that all railroad men should be given opportunity to see these things in the only convincing way—with their own eyes.

A VERY wise and commendable action has been taken by the directors of the New York, Ontario & Western Railroad in reorganizing the management, and among other changes creating the office of Chief Engineer. The time is past when it was supposed that upon a railroad being once completed and in operation an engineer's services were no longer required; but many companies are nominally still without any engineering staff, such work as ordinarily comes under a Chief Engineer's supervision being divided among a Bridge Superintendent, an Engineer of Roadway and other officers, or else entrusted to the General Manager, who, perhaps, calls in temporary assistance when it is required.

We wish in no way to reflect on the character of the engineering work which has been done on the New York, Ontario & Western road under the past regime. The General Manager is himself an engineer. The designing and adoption of the standard bridge guard, which we have so often referred to and commended, is alone an achievement of which the engineering staff of any road may well be proud. But the fact remains, nevertheless, that a certain important and responsible class of duties in connection with the work of railway maintenance, call for a high order of engineering talent and should be under the supervision of a single officer, for whom the most appropriate title is Chief Engineer. There is a certain tendency when this work is divided up among different departments, for doubt and ambiguity to arise as to the exact work which belongs to each department and also for the chief of each department to regard it as of secondary importance to other work which requires a larger portion of his time. This is plainly detrimental to the interests of safety, and in the long run it will be found that economy also demands that a company shall not attempt to do without a Chief Engineer, either in fact or name.

IT is stated that after the recent accident on the Manchester, Sheffield & Lincolnshire Railroad, the employés of the company held meetings to consider what action they could take to assist in relieving it from the heavy financial losses occasioned by the disaster. Subscription papers were made up and the men gave their wages for such a time as they could severally afford, averaging about a week for all. A delegation was appointed to offer the contribution to the board of directors, who expressed their appreciation of the good-will manifested by the men, but declined it on the ground that the stockholders were on the whole better able to bear the loss. The explanation of this unusual attitude of labor toward capital is found in the fact that the company has cultivated the good will of its employés in many ways. The Mutual Benefit Society and Savings Bank have been looked after and assisted, and the directors have established a fund for providing an allowance to superannuated salaried officials and propose ultimately to pension all employés.

Such a harmonious relation between capital

and labor as the above is very gratifying, and is certainly preferable to the intermittent warfare which is a far more common state of affairs. We must seriously question, however, whether such a relation between employers and their men will ever become common or is desirable in this country. There is a little too much of paternal supervision over the affairs of the men to agree with the independent ideas of American wage-earners. Mutual Benefit associations are common, and are popular so long as they are run by the members themselves; but any move toward guiding the investments of employés or obliging them to be frugal by any form of the pension system will be apt to meet with some opposition from those whom it is intended to benefit. There is an underlying belief in this country that every tub should be permitted to stand upon its own bottom, and a very large proportion of men had rather mismanage their own affairs than trust them to another's care.

The Niagara River Water Power.

Any one of moderate familiarity with water power and the laws of hydraulics who has ever been ferried across the Niagara river at Buffalo, can hardly fail to have been more impressed by the evidences of enormous latent power going to waste than even at Niagara itself, for the reason that nowhere else can the enormous *volume* of water to be dealt with be quite so well appreciated. The rapids at Niagara, like all rapids, give one the impression of shallowness. The falls themselves give no evidence to the eye of the enormous thickness of the sheets of water passing over them. On the other hand, the great width and depth of the river at Buffalo, combined with its *comprehensibly* swift current of some 7 miles per hour, and its nearness to the city of Buffalo, give one a vivid sense of a sad waste of power which is hardly more obtrusively evident at the cataract itself, just as the mind is less impressed by the distance to the moon than by very moderate distances on the surface of the earth, which we may have to walk over.

Only in this way can be explained the interest which has been excited in the most unpromising project of utilizing on a vast scale the river current at Buffalo, by converting it into power. To promote this project a public offer was made, a few months since, of a prize of $100,000 for the best plan. The project originated with two gentlemen who were not engineers, and who obtained the pledge of the necessary sum by public subscription in Buffalo. It is stated with great probability that over 2,000 communications from inventors have been already received, many of them accompanied by plans, drawings, models and estimates of cost, and we may be certain that the end is not yet. Most of these plans are for current motors, as appears to have been contemplated by the projectors, and the one which has attracted most attention so far, is a kind of submerged endless chain of buckets which open to oppose the current going down, but shut up flat in going back up stream. Practically all the projects involve innovations on usual methods, as the conditions make almost unavoidable.

It is risking little to predict that the movement will come to nothing, even if the $100,000 prize should be finally awarded. Current motors in some form have been used from the very earliest ages, and were in fact the earliest and most obvious form of waterwheel. They have served, and are serving, a very useful purpose at thousands of points throughout the world where small amounts of power are needed, to be used on the spot, and complicated mechanism is inadmissible, as notably for pumping and irrigating. It is even probable that the invention of the dynamo may result in their more extensive and important use hereafter for the local generation of electricity, for it is the only convenient and economical way for extracting *small* amounts of power from large streams which have no great fall at any one point near to where power is needed.

But to extract any large amount of power from a river is a very different matter, and there can be no better illustration than the Niagara of the essential absurdity of such attempts, for it should succeed on the Niagara if anywhere.

The cross-section of the Niagara river at the point proposed is some 40,000 sq. ft., and the current something under 7 miles per hour, or 10 ft. per second. This current represents a stored energy in the water equivalent to a head of 1.56 ft. Taking the discharge at the somewhat excessive figure of 400,000 cu. ft. per second, each foot of fall of such a body of water represents a theoretical horse power of

$$\frac{40{,}000 \times 60 \times 62\frac{1}{2}}{33{,}000} = 45{,}333 \text{ H. P.}$$

and if *all* the power due to the current head of 1.56 ft. could be utilized, Buffalo would derive the very comfortable aggregate of over 67,000 H. P., from the current which has so impressed the imagination of some of its citizens.

But this would require that *all* the velocity should be taken out of the water, and that it should leave the floats or buckets with no velocity at all, or in other words it would require the backing up of the whole volume of the Niagara river until there was an actual head equivalent to the virtual head. Anything approaching to such a result, it need hardly be said, could be hoped for only by the wildly visionary. In proportion as the practicable area of the current motor falls below 40,000 sq. ft. the possible power must decrease, in the first place, and in the second place, the utmost which it could be rationally expected to *utilize* from that portion of the cross-section of the stream acting on the motors would be a power equivalent to a reduction of the speed of the current of about 1 mile per hour, equivalent to about 5 ins. of fall (1.56—1.13 = 0.43 ft.). This fall would only give 19,000 H. P. if the whole cross-section were utilized, and if we make the extravagant estimate that one-fifth of the cross-section of the stream can be opposed to current meters, we have not even then more than 3,800 H. P., gross.

But this power is not where it is needed; it has to be transferred to a distance, presumably through dynamos. Now the cost of generating a horse power by steam in boilers of about 500 H. P., according to an elaborate investigation made by Mr. CHAS. E. EMERY, is hardly more than $25 per H. P. per year (10 hours per day). In order to underbid steam materially, make good the loss of fully 50 per cent. in converting, transferring and reconverting the power, and afford a visible margin of possible profit to encourage the enterprize, the value of a horse-power at the motor could not be estimated at more than $5 per H. P. per annum; in fact, it is proposed to sell power at $10 per H. P. in another scheme which we shall mention. This leaves the enormous sum of $19,000 per year to repair, renew and pay interest on the cost of current motors having an effective cross-section of 8,000 sq. ft. and completely submerged "to avoid ice," but subject to little difficulties from anchor ice, and what is known on the St. Lawrence as "frazil," or needle ice forming in a solid mass under the top sheet of ice; which would be more than likely to make a large submerged motor utterly impracticable in the winter season in that climate.

Granting that the numerous possible sources of fractional error in this estimate all make in favor of the project, there would be nothing in it to encourage sensible men if it were *on paper* three or four times as favorable. It is a pity, therefore, that the worthy citizens who set this movement going, did not first take the precaution to pay a few hundred dollars out of their $100,000 for the opinion of some expert hydraulic engineer, who would quite certainly have told them that current motors of great power have been an *ignis fatuus* for generations and have utterly failed to stand the test of the only rational system of development, proceeding from small things to great by gradual steps, as success warrants. Morally they had no right to do anything else, for although there is no law to prevent setting thousands of visionary men at work on a visionary project by the offer of a large reward, it is morally indefensible to do so without first taking reasonable care to make sure that the project has some element of the practicable about it.

Far different is the project which, we are happy to say, is now attracting a more rational attention in western New York, that namely, to utilize a fraction of the vast power of the Niagara river in an approved and customary way by driving a tunnel from below Niagara Falls to serve as a tail race. It is plain that, this once done, it will only be necessary to sink a shaft anywhere to connect with the tunnel and let on water from the Niagara river by an open channel to have an indefinitely great water-power available, according to requirements. In this project there is nothing of the experimental or of the doubtful, so far as its engineering features are concerned. It is a pure question of dollars and cents, with the advantage that the main permanent plant, once properly constructed, will be practically imperishable. The material through which it is proposed to drive this tail-race tunnel is the soft shale underlying the falls. It would quite certainly need lining, but according to the estimates which have been made and under present probabilities, $500,000 per mile will cover the cost of a tunnel 24 ft. in diameter. The new Croton Aqueduct tunnel, equivalent to about 14 ft. clear diameter, lined throughout and through much worse rock, is costing only a little over $300,000 per mile.

This cost, however, and even a considerably less sum, is far too high to warrant the mammoth project of running a tail-race tunnel directly to Buffalo, some 22 miles from the Falls, which has been talked about not a little in the papers and still more in private conversation, and which we understand to be one of the schemes which are competing for the $100,000 prize. The maximum possible grade for such a tunnel between the foot of the Falls (309 ft.) and Lake Erie (573 ft.) if it were to leave a working head of some 80 ft. or more at Buffalo, is somewhat under 8 ft. per mile. A tunnel 20 ft. in diameter and falling 8 ft. per mile would have a current velocity, if running full, of about 11 ft. per second, and discharge about 200,000 cu. ft. per minute, which is well up toward 1 per cent. of the total discharge of the Niagara river, the latter being 20,000,000 to 24,000,000 cu. ft. per minute. As it takes about 6½ cu. ft. of water falling 80 ft. to give a gross horse-power, this would generate 30,000 H. P. gross, or considerably over 20,000 H. P. effective, allowing for all sources of loss. At $10 per H. P. this would afford a revenue of about $200,000, available to pay interest on the investment, which fence could not exceed, at 5 per cent., $4,000,000, to still leave the project an attractive one. With a larger fall for the tail-race, a much greater power would be given, but no larger fall can be had. It would

require a fall of 100 ft. per mile to give four times the velocity and power, and any such velocity of current (some 30 miles per hour) would be hardly consistent with the permanency of any tunnel lining. To enlarge the cross-section of the tunnel enough to materially alter this calculation would involve too great elements of uncertainty. These computations show that even at $20 per H. P., which is a common price for water privileges in New England, it would take fully 30,000 H. P. to pay interest on the probable cost of the works, even allowing that customers for so large an amount of power could be found within a reasonable time, and hence the long tunnel scheme is utterly impracticable.

The project which is finding most favor, however, and which now seems to have a very fair chance for going through, is a less ambitious one. Starting from just below the upper suspension bridge at the Falls it is proposed to drive a tail-race tunnel, 24 ft. in diameter and 2½ miles long, parallel with the river bank and 400 or 500 ft. back therefrom on a grade of 80 ft. per mile for the first mile, which brings it about 120 ft. below the surface, and thence on an easier grade so as to be some 75 ft. below the surface at the end of the 2½ miles. The total cost of the work, including 24 cross tunnels, 4 shafts for constructing the main tunnel, 12 feed race-ways, and some other necessary works, is placed at $2,250,000, which ought to be sufficient; to which is to be added about $250,000 for land and similar expenses. The land for mill sites it is proposed to give away, relying on rentals of power at the before specified rate of $10 per H. P. for interest on the investment. At 5 per cent. it would be necessary to dispose of 12,500 H. P. to barely pay the interest, equivalent to 25 mill sites calling for 500 H. P. each. This alone means a large manufacturing town, but certainly, under such favorable conditions, it should be possible to dispose of them, although singularly little tendency has been shown so far to utilize a few drops of the vast current by less expensive surface works adjacent to the Falls.

It is publicly announced, however, that the tunnel is expected to potentially develope 119,000 H. P., which would require a tail-race velocity of over 20 miles per hour if there were no loss of energy whatever. Practically, it would have to be at least 25 miles per hour. This velocity would just about be given by the rate of fall, or so nearly so that at least 100,000 H. P. might be counted on if the tail race would stand the current, as it probably could be made to do, with occasional days off for repairs, and hence it would open a very gratifying prospect of financial profit *if* customers can be found for the power. The "if" is a very large one, but the project has no other element of the visionary or the doubtful about it, and as this is an era of rapid expansion in manufacturing, we shall be surprised if the project is not carried out ere long, and without ruining any of those who embark in it, especially as modern discoveries open a wide field for the conversion of power into electricity for transfer to Buffalo for lighting and power, or for the charging of storage batteries for transmission to any distance. Any considerable further improvement of the storage battery, which there is strong reason to hope for, would open a very wide market for large amounts of power.

Railroad Consolidation in New Hampshire.

After a continuous session of 158 days, 56 days longer than any session ever before held in the State, the New Hampshire legislature adjourned and left the railroad affairs of the State in a thoroughly chaotic condition. The deadlock between the majority in the legislature, who favored the Hazen bill, and the minority, who were aided by the Governor's veto in opposing it, has resulted in defeating all railway legislation and leaving the opposing factions, whose bitter partisanship equals anything found in political campaigns, to continue the struggle indefinitely.

It is not because of its intrinsic importance, that we have given so much space to accounts of this struggle; but because the general principle involved is one which has been and is to be, fought over in the legislatures and courts of every State, and because the general public takes, most unfortunately, an entirely erroneous view of the real facts in the case. The recent editorials in papers like the Springfield *Republican*, the New York *World* and *Times*, which condemn so strongly the attempt to consolidate the New Hampshire railroads under one management, reflect merely a general public sentiment in the matter, as honest as it is mistaken. The *Times* puts the question: "Is it better for the Commonwealth that independent home railroad corporation shall continue to exist, with the possibility of competition, or that all of them shall pass into the hands of one corporation controlled outside the State?" and seems to think it manifest without argument that the former alternative is the preferable one.

Such an assumption cannot stand. Railway consolidation is beneficial to the general public because it enables traffic to be carried on at less expense, and thus enables the company to charge lower rates; also because the work of a large corporation may be so systematized and inspected by a grade of engineering talent which small companies cannot afford to employ, that the safety of traffic on the line is greatly increased.

The argument against consolidation is first the *character* of the company, and this is a point where legislation and public opinion is often grievously at fault. Because a corporation has the legal attributes of a person it seems to be thought that it must have moral attributes as well. The moral character of the corporation does exist in the person of its managers, but inasmuch as the management is continually changing and generally much faster than the company's reputation, we have the anomaly of "sound and safe" companies proving corrupt, and well managed corporations suffering from the reputation given by former unworthy chiefs. Evidently then the partiality shown toward certain corporations by legislatures is wrong in principle. Non-discrimination should be the policy of the public toward the railroads as well as of the railroads toward the public. To try to obstruct the natural tendency of production to effect its ends in the cheapest possible manner by consolidating its interests is against the public good.

But the real bone of contention after all is the bugbear of monopoly, the fear that when all the railroad communication of a section is in the hands of one company, that rates will be raised to a grievously high point. It is not to be denied that this tendency exists. Corporations do business for gain, and will tend to charge such rates as make their gains greatest. At present, competition is practically our sole weapon for resisting this tendency, and consider how weak and ineffective it is. When all the transportation lines are built which the country can afford, the great bulk of traffic will still be carried on between points between which there is no choice of routes and no competition. Again, consider that the essence of competition is strife, and see if the ingenuity of courts and legislators will ever be sufficient to keep corporations continually fighting if they really desire to be at peace. Consolidation has gone on until all but an insignificant fraction of our American mileage is owned by great corporations. No one would seriously argue that it would be an advantage to split up these great systems into the small local lines locally managed from which they were formed, for such a move would raise transportation rates of necessity to an enormous figure. Why is it any more reasonable to argue against consolidation in New England than in the West, or to attempt to stop further consolidation than it is to condemn what has already taken place.

It is certainly true that wise and just enactments are needed on our statute books to regulate the affairs, both financial and technical, of our railroad corporations. But legislation that seeks to benefit the patrons of the roads only, and does not regard the rights and requirements of the corporations as well, will return like a boomerang and inflict injury instead of benefit upon the general public.

The Panama Canal.

Senor ARMERO, in his report on the Panama Canal for the Colombian Government, an abstract of which is elsewhere given, handles the subject rather severely. But this report, coming as it does from one who by virtue of his official position should be in possession of complete and correct data, is worthy of particular attention at this time.

Boiled down, his report means that out of a total estimated quantity of 161,000,000 c. m. of excavation, only 33,925,230 c. m. were moved on Sept. 1, 1887, about 21 per cent. To accomplish this the canal company has expended $163,606,400. The work done also represents the easier portion while the remaining four-fifths will necessarily be more troublesome and expensive as being nearer the water level and below it. The estimate of $94,000,000 for controlling the waters of the Chagres is an enormous amount, but scarcely more so than the task contemplated. The cost per cubic metre of the work done is figured at $2.00, but Senor ARMERO thinks that twice this sum per metre will be demanded for the remaining work, and including the Gamboa dam, he estimates that about $600,000,000 will still be needed to finish the canal; in other words, the final cost of the canal will exceed $763,000,000, without including the enormous interest account.

In a portion of the report, not printed in the abstract elsewhere given, Senor ARMERO hints that some one made $13,650,880 profit on the transfer of the Panama railway to the Canal company, by selling at $250 gold and accrued interest, shares that shortly before were worth $80 in the open market. He further remarks that the Colombian Government lays a claim to one-half of these profits, and sooner or later will demand it from either the canal or the railway company.

Merely for the purpose of refreshing the memory of our readers we attempt to arrange the financial history of the canal in a tabular form; but as we have no record at hand of the actual money received from the first issue of 1880, the total does not quite agree with the lump sum given in the report. This record would stand about as follows:

Date.	*Amount and Rate of Issues.*	*Cash Received. francs.*
1880	Original capital.....	300,000,000
1882	250,000 shares, 5 per cent. sold at 437½f. on 500f.....	109,375,000
1883	600,000 3 per cent. bonds sold at 225f. on 500f.....	135,000,000
1884	402,867 4 per cent. bonds sold at 333f. on 500f.....	136,419,111
1886	800,000 shares, of which 468,802 were taken at 450f. on 1,000f.....	206,460,000
1887	500,000 shares of which 230,887 were taken at 440f. on 1,000 f.....	113,910,280
		1,001,163,391f.

The final conclusions of Senor ARMERO are

significant. He believes the canal will be finished, for the reason that too much work has already been done and too much money already spent to permit it to be abandoned. The "honor of France" is also at stake, and the enterprise is not simply an industrial business involving the interests of a company, but it is a work of universal character. But he also says that at the present rate of progress the canal cannot be finished in 10 years, and in that lapse of time the interest account alone will have swallowed everything. And further, that by no possible curtailment of work can the canal be opened to traffic in 1889 or in 1892, and in the latter year the concession with the Colombian Government lapses, and the Colombian authorities must be prepared to meet this eventuality.

In foretelling the final completion of the canal in the face of the present disastrous financial policy of its managers, Senor ARMERO does not say how the sums necessary to pay for labor and materials are to be raised. The intimation that France may take hold of it as a national work will involve that nation in some rather delicate complications with the Monroe doctrine, and the United States might have something to say in the matter. There is this to say, however, in this connection that the United States has without a protest permitted Frenchmen to invest an enormous sum of their money on the Isthmus; and if France as a nation sees fit to prevent the catastrophe to its people that the loss of this money would mean, and would propose to complete the canal on a purely neutral basis, open on equal terms to the commerce of the world, we do not see just how our country could consistently object. It would simply mean a treaty on this basis, and it would be our duty to see to it that the canal was maintained neutral. France has had too disastrous an experience in Mexico, and has too much to attend to with her immediate neighbors to allow her ambition to get the better of her common sense and attempt to transform Colombia into a French dependency, as some people seem to fear.

We admire the courage and faith of the "grand Frenchman" who has taken upon his shoulders, in his old age, this, the most colossal task of modern times, compared with which his Suez canal was mere child's play. But even he is losing his prestige under conditions over which he probably has no control, and each year makes it more difficult to collect further sums to be swallowed in the insatiable maw of the Panama canal. His last loan is only half taken, even at a discount of 56 per cent., and the query is what will he do next? De LESSEPS is fruitful in promises and hopeful to the end, but the most charitable conclusion is that his great obligation to the French people whom he has enlisted in this enterprise and his greater faith in himself and his past achievements, are blinding him to facts and to the almost hopeless conditions surrounding him. Even within the week he announces that he is negotiating with M. EIFFEL with the purpose of insuring a traffic of 7,500,000 tons yearly across the Isthmus, and from "the annual profits" will complete the canal as he did at Suez. But there was no Culebra mountain across the path of the Suez canal, and no Chagres river, the one to be dug through and the other turned into a new channel before *anything* can be done in the way of maintaining traffic. The Suez crossed a sandy plain, while the Panama canal must pierce mountains and has an angry river by its side ever threatening destruction, and the two canals can not be compared, when we seek the quantities of time and cost. It would be a pity if so much human energy and so much hard earned capital were to be wasted in this undertaking, and with Senor ARMERO we hope this will not come to pass. But we must at the same time admit that we can not see how this wished for result is to be accomplished under the present management and methods of work.

Cost of the Panama Canal from a Colombian Government Standpoint.

The Colombian Government, through its agent Senor NICOLAS TANCO ARMERO, has been investigating the Panama Canal on its own account, with the following results:

"According to the plans, the number of cubic metres to be excavated in order to open the canal was 143,000,000, and to these figures must be added the quantity of earth to be moved in order to lead off the waters of the Chagres, Obispo and the Grande Rivers, which amounts to 18,000,000 cubic metres, making the total excavations amount to 161,000,000 cubic metres, and as the amount taken out up to the end of August of the present year was 33,925,230 cubic meters, according to the figures of the company, there yet remain 127,075,770 cubic metres to be removed. As up to date the sum expended is 818,023,900 francs, it is evident that the cost per metre of work has been exorbitant. Were we to base our calculations on these figures, the total cost of the canal would become fabulous, and it would probably never be finished. But this is not the way to calculate. We have to look at the costly preliminary works, the purchase of the railroad, the immense amounts of materials which had to be collected, and the purchase and erection of buildings, all of which were expenses which had to be met in order that a work should progress which is perhaps the most important and colossal of modern or any times. Thus the expense of work per metre has diminished as the work has progressed, and only when it shall have been completed shall we be able to determine the cost of all the excavations.

"I may add that already the upper and easier work has been executed, and that greater difficulties will be encountered in working as the tide level is approached and the sea begins to flow into the whole canal. At the Culebra section hills 339 ft. above the sea level had to be pierced, and here the quantity of rock and earth to be removed assumes gigantic proportions. At least 15,000,000 cubic metres must be transported about 18 kilometres and thrown into Panama bay, as the Valley of Paraiso will be filled when 3,000,000 metres shall have been thrown there, and the same will be true of Emperador and Obispo. The removal of this excavated material to such a distance will involve considerable outlay. The works on the Chagres river, in order to turn it, which have hardly been begun, will be the most difficult and costly of all. The dam here will be 1,200 metres in length, 430 in width, and 45 in height. Behind it there will be 3,000,000 cubic meters of water banked up. The hills on which the flanks of this gigantic dam will rest will be tunneled, and through these tunnels will flow to another watershed the water which otherwise would follow the course of the canal, and they will find their way to the sea at points many miles distant from their former outlets. An engineer has informed me that the cost of thus controlling the waters of the Chagres will amount to $94,340,000, or 471,700,000 francs.

"The ordinary price which has been paid for every cubic metre which has been excavated has bee n $1.50 but to this sum must be added the expenses of management, which bring the figure up to $2 at least per cubic metre. And this has been paid for the easy part of the work, while that which is lacking, 127,074,770 cubic metres, more or less, will cost double this figure; consequently there must yet be expended the enormous sum of $506,299,080, or 2,541,495,400 francs. Add this to the cost of the Gamboa dam—that is to say 471,000,000 francs—and we obtain a total of 3,012,495,400 francs. This is the amount of gold which is still required before a good maritime canal can be made, without reckoning upon the sum the company must pay for interest on the capital already loaned and general expenses, and which, if the work is not concluded within the next six or eight years, will easily amount to another 1,000,000,000 francs."

The report says that the company already received in cash 1,031,943,100 francs, and, as Count de LESSEPS says, there are still in hand about 100,000,000 francs of the August loan, there should be altogether today in hand 213,910,280 francs. By deducting this amount from the total cash received it shows that the company has already expended 818,032,900 francs. "It must be remembered," the report says, "that the expenses of management, interest, etc., amount annually to 100,000,000 francs, which will continue to augment, now that additional interest must be paid on the new loan, and 3,000 000,000 francs more will be required to complete the canal. Thus we are compelled to reflect that the company will annually obtain less money, even should it offer higher interest, and it is absolutely certain that it will be difficult to obtain the requisite fabulous sum, and the more particularly so since the financial situation of the company is serious, is involved, and is alarming."

Faster Time across the Continent.

WHAT may be accomplished in shortening the journey from ocean to ocean by a little harmonious effort on the part of the managers of the great Western systems is shown by the announcement that the Union Pacific and Central Pacific have put on a through express train from Omaha to San Francisco which shortens the journey between those points about 15½ hours. This makes the time from New York to San Francisco just five days, and the New Yorker who has scruples against journeying on the Sabbath, may now pack his trunk in this city on Monday, take the express at night, and roll into San Francisco on Saturday evening in time to be importuned by half a dozen real estate agents to buy corner lots in some of California's booming but still youthful cities.

But that all that is possible has not yet been accomplished in this direction is evident by noting the actual running time. Calling the distance from New York to San Francisco, 3,270 miles and the time 120 hours, we have an average speed exclusive of stops of about 27¼ miles per hour. Compare this with the speed of the Pennsylvania limited express which makes the run from New York to Chicago, 912 miles in 25 hours, an average speed of 36½ miles per hour, and it is plain that with all the disadvantages of mountain grades and rougher roads to which the Pacific roads are subject, there is yet room for great improvement in the schedule time of through trains. Still more evident is this by noting that the speed of the Pennsylvania limited over the first division of the trip, New York to Philadelphia, is 46½ miles per hour.

There is considerable probability of a war in passenger tariffs resulting among the Western companies on account of the above bit of enterprise by the Union Pacific. The Burlington proposes to put on a fast train, reducing the time from Chicago to Denver by 12 hours. The Atchison and some other companies, who find it difficult to compete in speed with the others, propose to cut rates, and there is little doubt that the Union Pacific will meet the cut. At the same time it really seems as if the fast express would really affect the Atchison but little As long as it takes passengers to San Francisco by way of Southern California it cannot expect to complete very closely in time with the direct lines through Utah, though when the new cut-off through the Texas Panhandle is finished, the difference will not be so material as now. If the fond hopes of the promoters of the booms in the great and little cities of Southern California are realized, the Santa Fe will ere long have no need to look for San Francisco business, but will have all its facilities taxed to carry the traffic of Los Angeles and the other vast cities of that rapid region.

THE Steel Company, of Scotland, is suing the contractors, of the Forth bridge, for £100,000 damages. It seems that this company offered to supply the whole of the steel, less 12,000 tons of plates, at from £9 10s. ($43.56) to £14 ($67.76) per ton. The tender stated that it was understood that the estimated quantity would be 30,000 tons "more or less." The offer was accepted and up to the end of last May 26,230 tons had been delivered. But the contractors discovered that they could obtain cheaper steel, and now maintain that where an estimated quantity is given, custom allows a margin of not more than 5 per cent., which would be the meaning of the phrase "more or less," and so long as 30,000 tons are taken the contractors can go elsewhere for the balance wanted. The case is assuming a complicated shape, as steel has fallen in price since the contract was made; steel is now being used where iron was originally contemplated, and 10,000 tons of steel may be used in a separate contract in connection with the bridge. The question to be decided by the Courts is, shall the steel of the original company be used in these changes and additions and what the term "more or less" means in law.

THE Swannanoa tunnel on the Western North Carolina Railroad caved in Nov. 5.

CORRESPONDENCE.

Trench Blasting in Cities.

NEW YORK, Nov. 14, 1887.

EDITOR ENGINEERING NEWS:

In the article on tamping on the 5th inst., there occurs this expression: "heavy curtains of logs, chained together, and other covering, do not always prevent the projection of work from the trench." I think the most of the failure is attributable to the fact that the first word of the quotation is properly applied, viz. the curtain or cover is too heavy. The blow delivered by a blast on the cover may be compared to that of the bat on a baseball. If the ball is in good order it is *hard*, and a blow will send it far and *hot*. If the same blow were spent on a football or a small bag of feathers, it would not send it far, nor could it be *hot*. The same remark will apply to the cover of a blast. If of logs, unchained, the high specific gravity of the logs will send them flying high and far. Chained they will not fly so far because much of the initial force is spent in stretching the chains. If the first blow breaks the chain, both logs and stones will fly and scatter. It must furthermore be very difficult to lay such logs close enough together to prevent the exit between them of smaller fragments. Near buildings loose logs may do nearly as much damage as stones.

It is reasonable then to assume that the curtain or cover should consist of some light and elastic material which will, when projected, encounter more resistance from the air than the logs, and yield more to the blow of the blast. I would like to see someone try fascines of yellow birch, or similar tough brush. They might be made in round bundles, 10 to 15 ft. long, and of convenient diameter. Or they might be made in shape like *mattresses*, of any size preferred. They could be tied with wire, or withes, or cotton ties. They would be easy to handle, could be laid close, doubled or crossed, and could, in extra hazardous situations, be loaded with partially filled sand bags. They would lay close, preventing spalls from getting through, and they would catch so much air that it would be impossible to send them flying any great distance. In ball-players language, they would never fly *hot*. Above all, *they would be cheap*, and if well made, should last a long time, besides being easy to repair.

There is much to be desired yet, in the way of economy in drilling holes for *good* blasting and in the proper use of high explosives. The air space in tamping will undoubtedly save powder, but the hole has to be of proper depth to make it really efficient. The explosive, too, is generally of too low a grade to get the best results without throwing the rock. The lower the grade of the powder, the more will it throw under equal conditions.

If some one will try this fascine or mattress cover and give you the results, I will cheerfully explain further details if needed. K.

SOCIETY PROCEEDINGS.

American Society of Civil Engineers.—Meeting of Nov. 16, President WORTHEN presiding. In the absence of the Secretary, Mr. THEO. COOPER read the first paper of the evening which was by Mr. C. L. STROBEL on "Experiments upon Z-iron Columns," illustrated by diagrams. The paper was discussed by Messrs. LINDENTHAL, EMERY and WHISTLER. The second paper was by Mr. A. P. BOLLER on "Tests of a Wrought-Iron Double Track Floor Beam." This test was to destruction under the stress of 4 hydraulic jacks, and the reading of the paper and the views expressed therein called out criticism on the design of the girder and method of testing from Messrs. C. O. BROWN, BUCK, LINDENTHAL, COOPER, EMERY, etc. Later Mr. S. S. WHEELER exhibited and explained a chart prepared by him to show the vagaries of the thirty odd "standard gauges" in use for a variety of industrial purposes. Mr. WHEELER explained, as well as patient research could ascertain, the reasons for the difference between gauges, and advocated the adoption of the Brown & Sharp American gauge for all use in America as being acknowledged by nations generally as the most perfect and scientifically constructed and regular in its increments of gauge size. Mr. METCALF thought that the use of the micrometer gauge made manufacturers independent of the inaccuracies of "standard" gauges, such as are usually supplied to the trade. He argued that it was folly to suppose that one could obtain for $4.50—the usual price—a gauge which would be as closely and accurately divided as the gauge numbers indicated and a comparison of any two or three gauges of the same standard would prove this. A set of Whitworth's gauges costs about $1,000. He found no difficulty in teaching his workmen the use of the micrometer, and it was used for all purposes in his works to the entire exclusion of the usual gauge.

Messrs. L. L. BUCK, E. S. PHILBRICK and THOMAS J. WHITMAN, Members Am. Soc. C. E. have been appointed the Board of Censors to award the Norman Medal of the American Society of Civil Engineers. The Rowland Prize Committee are Messrs. E. SHERMAN GOULD, G. LINDENTHAL, Members, Am. Soc. C. E., and the Secretary. Both Committees will report at the Annual Meeting, January 18, 1888.

Engineers' Club of Philadelphia.—Record of business meeting, November 5, 1887. President T. M. CLEEMANN in the chair; 17 members present. The Tellers of Election reported the following elected Active Members of the club; Messrs. HENRY I. SNELL HENRY B. SEAMAN, FRANK COOPER, ARTHUR H. WOOD, ERWIN GRAVES, I. H WAINWRIGHT and FRED. J. AMWEG. The Secretary called attention to the fact that the 17th of December of this year would be the tenth anniversary of the organization of the club, and recommended that t be observed by the holding of a reception in the club house on that evening. After some discussion the following resolution, offered by Mr. JOHN T. BOYD, was unanimously adopted:

Resolved, That a Committee, with power to act, be appointed to take charge of a Decennial Anniversary Reception, to be held in club house on Dec. 17th, 1887, at 8 o'clock P. M.; said Committee to consist of as many members as Chair may decide, who shall issue cards of invitation, given on request of members, the latter to be entitled to invite not exceeding three members of the engineering or architectural professions, all members being requested to subscribe two dollars by notice sent by the Secretary, and that such other invitations may be issued as the Committee shall deem proper and desirable.

Mr. BOYD declined, on account of pressure of business, to serve on the Committee, which the President appointed as follows: PERCIVAL ROBERTS, JR., *Chairman*, E. V. D'INVILLIERS, PROF. L. M. HAUPT, C. G. DARRACH, FREDERIC GRAFF.

Mr. C. G. DARRACH presented a paper upon "Boiler Specifications," which was discussed at length by Messrs. JOHN T. BOYD, CHAS. T. THOMPSON, A. MARICHAL, J. E. CODMAN and others.

HOWARD MURPHY, *Sec. and Treas*

Engineers' Club of St. Louis.—Meeting of Nov. 2, 1887. The club met at 8.10 P. M. at Washington University, President POTTER in the chair, nineteen members and one visitor present. The executive committee submitted the following report on programme, which was adopted:

ST. LOUIS, Nov. 2, 1887.

GENTLEMEN.—Your executive committee beg leave to submit the following programme of the club's work for the coming year. Meetings have been arranged for the first and third Wednesdays of each month up to June next. It is not expected that this plan can be rigidly adhered to, but it will serve as a basis to work upon, and will be followed as closely as circumstances permit.

November 2nd.—Charles E. Jones, "Steam Heating at Washington University."

November 16th.—Prof. J. B. Johnson, "Testing the Strength of Engineering Materials."

December 7th.—Annual meeting. P. M. Bruner, "The Action of Frost on Concrete Work."

December 21.—Isaac A. Smith, "Rapid Railway Embankment Construction."

January 4th.—Charles H. Ledlie, "Construction of Dam and Reservoir at Athens, Ga."; Charles W. Bryan, "Railway Bridge Designing."

January 18th.—Carl Gaylor, "Floors of Street Bridges;" N. W. Eayrs, "The Improvement of Nantucket Harbor, Mass."

February 1st.—Prof. F. E. Nipher, "Graphical Solution of the Action of the Series Dynamo;" B. F. Crow, "Constructive Accounts."

February 15th.—Robert Moore, "Sizes of Railroad Culverts;" O. L. Petitdidier, "Practical Notes on Masonry and Stone Laying."

March 7th.—Prof H. B. Gale, "The Transmission of Power by Belting;" Samuel F. Burnet, "Cement and Mortar."

March 21.—Prof. W. B. Potter, "St. Louis Water Supply."

April 4th.—S. Bent Russel, "Thickness of Water Pipes;" H. A. Wheeler, (subject not yet announced.)

April 18th.—Prof. C. M. Woodward, "Gas Producers;" Lewis Stockett, "A Well Ventilated Mine"

May 2nd.—Col. E. D. Meier, "Standards of Boiler Efficiency;" Chas. F. White, "The Failure of a Firmenich Boiler."

May 16th.—R. E. McMath, "The Waterway Between the Lakes and the Mississippi River."

June 6th.—M. L. Holman, "The Temporary Low Service Pumping Plant at St. Louis."

Partial promises have been made of other papers on topics of interest. These will be presented as opportunity occurs and due notice given. EXECUTIVE COMMITTEE. W. H. BRYAN, Sec'y.

The following applications for membership were announced and referred to the executive committee: ALLAN C. GLASGOW, ROBERT F. GRADY, JOHN A. LAIRD, FRANK NICHOLSON, PETER W. SCHAUMLEFFEL, JOHN P. THUL.

Prof. JOHNSON read a communication from the board of managers of the Association of Engineering Societies, on the subject of a closer union between the societies now in the association and others. On motion, the consideration of this paper was made a special order for the next meeting, November 16.

Mr. CHAS. E. JONES then read a paper on "Steam Heating at Washington University, and Experience with Underground Pipes." The history of the system in use was given with details of its construction and the work done. It was shown that the boilers were regularly doing double the duty which was originally expected of them. The evaporative efficiency did not seem to be reduced when the boilers were forced in this manner. Great efforts had been made to reduce the smoke, and many devices had been tested. All had failed on account of the excessive duty required of the boilers. The underground pipes had failed after years of service from external corrosion due to the accidental admission of moisture to the conduits. New pipes had been laid recently, and the construction of the new conduit was shown.

Professors WOODWARD, POTTER, GALE and Messrs BRYAN and SHARMAN took part in the discussion. Mr. JONES added that a new stack had just been erected, which had increased the draft sufficiently to permit the introduction of a small amount of air above the grates. This had resulted in an appreciable reduction of the smoke. WM. H. BRYAN, Secretary.

Michigan Engineering Society.—The Society has been incorporated under the laws of the State by the members of the original Michigan Engineering Society thus virtually organizing a new society. The 9th Annual Convention, and the first meeting of the new society for the adoption of constitution, and by-laws and the election of officers, will be held at the American House, Kalamazoo, Mich., January 17, 1888. The following papers are promised: "Combination Bids, and "Plane Table Surveying," by Prof. J. B. DAVIS of Ann Arbor; "Difficult Railroad Foundation," by O. C. GILLETTE; "Sources of Error in the Gradienter," by H. C. PEARSONS; "U. S. Surveys in Florida," by S. C. HODGMAN; "Surveys in Oregon," by ISAAC TELLER. Papers are also expected from Prof. COOLEY, of Ann Arbor; Prof. CARPENTER, of Lansing; WM. APPLETON, of Lansing; EDWARD BARRINGTON, of Superior, Neb.; A. L. REED, JOSEPH RIPLEY and FRANK P. DAVIS. Negotiations are pending for the usual special railroad rates. For circulars and particulars address the Secretary, F. HODGMAN, Climax, Mich.

Connecticut Association of Civil Engineers and Surveyors.—The Fall meeting of the Association was held Nov. 9 at the office of Mr. C. H. BUNCE, City Surveyor, Hartford, Conn. The attendance was exceptionally small, only 13 members being present; this was attributed partly to this being the time of year when engineers are busy finishing up work for the winter, and partly to the fact that some of the members had not received due notice. There seemed to be, also, a prevailing opinion that the "Waterbury crowd," not having attended several meetings, needed stirring up.

Mr. GEO. W. FULLER, of Norwich, wrote that he had been unable to complete his paper on "The Preparation of Submarine Foundations," and would not be able to attend. Mr. E. P. AUGUR, of Middletown, who was down on the programme for the second paper, did not arrive, and in reply to a telegram wired that he had not known of the meeting and could not come. Under these circumstances the meeting was not called to order till some time after the programme hour. A proposed alteration to the constitution was submitted, providing for the change of title of Contributing Members to Associate Members, and for the reduction of the annual fees of such members from $5 to $3, making them the same as for Active Members. This was referred for final action at the next annual meeting. No papers being presented, and the "question box" being empty, the meeting adjourned till 2 p. m., and the members went to examine the Asylum street drawbridge, a plate girder, deck bridge, 70 ft. span, the largest plate girder drawbridge in the country. It revolves on a center pivot and track, and when closed takes a bearing on iron plates set in the abutments, slightly raised above the level of the masonry. The bridge was designed by Mr. CHARLES M. JARVIS, of the Berlin Bridge Co., a member of the Association, and met with the approval of the City Surveyor.

After dinner the meeting was called to order about 2.30 p. m. A new method of graduating level rods adapted especially for rapid work, was explained. Mr. C.E. CHANDLER then read a paper (published on another page) on "The Rental Value of Hydrant Service," for the purpose of opening a discussion, and after some remarks the subject was postponed for further discussion at the next meeting. The meeting then adjourned. Several of those present, on the way to the depot, took the opportunity of examining a self propelling steam fire-engine: the city has two of these engines, built by the Amoskeag Manufacturing Co., of Manchester, N. H., and their performance is said to be very satisfactory. Mr. BUNCE conducted several members around the site of the new depot and explained the proposed arrangement of the elevated tracks through the city.

The following members were present: C. E. CHANDLER, President: D. S. BRINSMADE, Secretary: H. W. AYRES, GEO. H. BISHOP, CHAS. H. BUNCE, D. H. BURNETT, EDGAR CLARK, F. B. DURFEY, ROBT. FENTON, E. P. GARDNER, C. M. JARVIS, T. H. MCKENZIE and WM. E. PETTEE.

The next meeting of the Association will be the Annual Meeting, January 10, 1888, which will in all probability be held at Hartford, at the office of Mr. BUNCE. Care will be taken to ensure a good attendance, and an interesting meeting is expected.

Engineer's Club of Kansas City.—At the regular meeting of the Engineer's Club of Kansas City, held NOV. 7, at the Club Room, No. 19 Deardoff Building, at 7.45 P. M., there were present Messrs. W. B. Knight, A. J. Mason, E. B. Kay, A. E. Swain, C. E. Taylor, S. A. Mitchell, T. F. Wynne, E. W. Stern, Clift Wise, Kenneth Allen and 5 visitors. After the routine business of the meeting was concluded. Mr. WYNKOOP KIERSTED read a paper on "Water Supply and its Development for Small Cities in the West," which was then discussed.

KENNETH ALLEN, *Secretary.*

Master Car-Builders' Association.—The Report of the Executive Committee of the Master Car-Builders Association having been approved by the Association, and the Janney Type of coupler having been made the Master Car-Builders' standard, a sub-committee has been appointed by the Executive Committee to consummate the recommendation of the report that "the Association procure one of present make of Janney Type of coupler, selection being made by a committee appointed for that purpose, and then all other forms of couplers that will couple to and with this coupler, under all conditions of service, are to be considered as within the Janney Type and conforming to the standard of this Association."

All parties who claim to manufacture couplers within the Master Car-Builders' Type are requested to send two couplers completely finished and ready for service, to R. D. WADE, Sup't of Motive Power, Richmond & Danville Railroad, 1300 Pennsylvania Avenue, Washington, D. C., on or before December 13, 1887. Such parties are further requested to send a representative, to appear before the committee on the above date and at the above place, who will with proper drawings describe the mechanical construction of the coupler he represents, such drawings to remain with the committee and become the permanent property of the Master Car-Builders' Association.

If in the judgment of the committee it should become necessary to attach the couplers to cars, the committee will provide cars, and facilities for testing, but all expenses incident to attaching the couplers must be defrayed by the owners of the couplers.

The committee will not consider models or drawings of couplers not represented by full-sized couplers ready for attachment to cars as above described.

The committee will make their report to the Executive Committee, who will issue drawings of the Master Car-Builders' Type, and officially announce the names of the couplers which are within this Type.

The members of the Master Car-Builders' Association are invited to meet with the Committee and assist them in their investigation of the various couplers.

EDWARD B. WALL, R. D. WADE, JOHN S. LENTZ, J. W. CLOUD, *Committee.*

New York, Nov. 15, 1887.

Liverpool Engineering Society.—The usual fortnightly meeting of this Society was held at the Royal Institute, Colquitt street, Liverpool, on Nov. 2. Mr. JOHN J. WEBSTER, M. Inst. C. E. President, in the chair. A paper was read by Mr. HENRY POOLEY, JR., entitled "Automatic Weighing Machines." The author commenced by giving a short account of the earliest form of compound lever weighing machine and its subsequent improvement by the addition of steelyard and weights. The further introduction of the steelyard without loose weights was then dealt with together with the circumstances which led to the adoption of self indicating machines. The attempts to make self indicating machines of high capacity on the spring balance principle were referred to and the reasons for their failure given. The invention of Messrs. ROBERTS and STROUDLEY of the combined lever and spring indicator was then described and an account was given of the experiments with the machine and the further invention of the hydrostatic indicator.

Automatic weighing apparatus for dealing with grain in bulk, rice, seed, etc., were then dealt with and an account was given of the obstacles thrown in the way of the introduction of such apparatus. The earlier forms of grain weighing apparatus and the invention of the equal beam weighing machines were then referred to, and a description given of the latter machine together with an account of certain experiments with it. The automatic grain weighing machine in its latest form was then described and the author concluded by describing the arrangement and working of the equal beam weighing machine and hopper.

LATEST CHANGES OF ADDRESS, AMERICAN SOCIETY OF CIVIL ENGINEERS.

H. L. AULLS, Room 65, Barclay Block, Denver, Colo.
AUGUSTUS P. BARNARD, Topeka, Kansas.
WILLIAM H. BAKER, Fitchburg, Mass.
JOHN S. DEANS, Asst. Eng. Estimating & Designing Dept. The Phœnix Bridge Co., Phœnixville, Pa.
H. C. DERRICK, Halifax C. H., Halifax Co., Va.
EDWIN A. DOANE, Vice Pres., Atlanta Starch Co., 11½ Broad St., Atlanta, Ga.
J. T. DODGE, 20 Third Ave., W. Duluth, Minn.
ARTHUR J. FRITH, care Advance Electric Co., 417 Pine St., St. Louis, Mo.
WILLIAM H. HEUER, Major Corps of Engineers, U. S A., Appraiser Bldg., San Francisco, Cal.
A. W. LOCKE, North Adams, Mass.
C. E. MARVIN, Roadmaster, Georgia Central R. R., Savannah, Ga.
GRATZ MORDECAI, care Fowler & Lummis, 436 Walnut St., Philadelphia, Pa.
F. M. RUTHERFORD, Engr. Maint. Way, Anniston & Atlantic R. R., Anniston, Ala.
GRANVILLE W. SHAW, Box 124, Louisville, Ky.
EDWIN THACHER, Chf. Eng. Decatur Iron Bridge & Construction Co., Decatur, Ala.
F. W. WATKINS, 118 East 118 St., New York City.
THOMAS J. WHITMAN, 417 Olive St., St. Louis, Mo.

Subscriptions to the Building Fund are to date, as follows:

Subscriptions previously reported.....	$8,719.50
Thomas C. Clarke.....	250.00
James Ross	100.00
	$9,069.50

PERSONAL.

EX. GOV. BENJ. F. PRESCOTT of Epping, N.H., has been appointed a Member of the New Hampshire Railroad Commission, to succeed E. J. TENNEY.

Mr. JOHN W. HILL, Mechanical Engineer, Room 21 Glenn Building, Cincinnati, O., is at present engaged as Consulting and Constructing Engineer upon the following works: Findlay, O., complete works, $270,000; Sidney, O., improvement of water-works, $80,000; Bellefontaine, O., improvement of water-works, $45,000; Franklin, O., new water-works, $45,000; Clarksburg, W. Va., new water works, $50,000. Mr. HILL expects to make the contracts for the Clarksburg water-works in January; to complete the contracts for Franklin during the present year, and to let the Findlay works during the winter. At Sidney and Bellefontaine, construction will be deferred until next season.

Mr. JAMES T. GARDNER, General Superintendent of the Buffalo, Rochester & Pittsburg R. R., has resigned his position.

Mr. C. F. DUTTON has been appointed General Manager of the Milwaukee R. R., and the office of General Superintendent, heretofore held by Mr. DUTTON, is abolished.

Mr. E. CANFIELD has been appointed Chief Engineer of the New York, Ontario & Western Railroad, with headquarters at Middletown, N. Y.

Mr. C. W. LAUPHER, who has been Superintendent of the Northern Division of the same road is to be Superintendent of Transportation, with headquarters at Norwich, N. Y.

M. A. DE QUEVEDO, Engineer des Ponts et Chaussees, has just returned from Guadalajara, Mexico, and is now in New York inspecting the harbor and docks of the city.

RENE DE FAVA, Civil Engineer and Architect, son of the Italian Minister, is now in New York inspecting the engineering works of the city and vicinity.

GEN. JOHN NEWTON and Messrs. EDGAR B. VAN WINKLE, GEORGE W. MCNULTY and THOMAS C. CLARKE, have been invited by the Board of Park Commissioners to examine the locality of Macomb's Dam Bridge and report as to the expediency of constructing a draw bridge, a fixed bridge, or a tunnel at or about that point and give an approximate estimate of the cost of such a construction.

Our thanks are tendered to the local Committee of the "Arkansas Society of Engineers, Architects and Surveyors" for their kind invitation to the banquet given to the Society by the citizens of Little Rock on the evening of the 11th, the programme and menu of which we have received. Unlike the older similar associations, this most recent organization has started in for more than three days of unremitting hard labor over papers and discussions; they propose to break into the habit of isolation common to land surveyors and not unusual among civil engineers and architects, a policy we recommend to the older societies.

ENGINEERING NEWS.

IT is reported that one mile of the Cape Cod ship canal is finished. Considering that this canal was originally chartered in 1670, more than 200 years ago, progress has been very gratifying, but the Panama canal may yet first be opened to traffic.

Messrs. JOS. M. WILSON, ALFRED P. BOLLER and DON. J. WHITTEMORE, the expert commission appointed to discuss and suggest plans for the improvement of the railway terminals in Providence, R. I., have commenced work.

NOTWITHSTANDING late rumors to the contrary, the Springfield *Republican*, of Nov. 11, says that the Westinghouse Co. is preparing to put 1250 incandescent lamps into the Hoosac tunnel. The driving of ventilating fans by electric motors is also contemplated.

RUMOR has it that the Balt. & Ohio R. R. Co. is to introduce the Manning automatic switch on the entire line of its road. It is the invention of W. T. MANNING, Engineer of Maintenance of Way on the Pittsburg Division.

THE *Bulletin du Canal Interoceanique*, for Nov. 2, in speaking of the September work—the detail of which is to be given in the next *Bulletin*—says that work on the Culebra cut is suffering from a lack of laborers, from the lack of proper drainage and the fact that a part of the plant is inactive; of the 13 excavators there, four have been at work and 9 standing still all the month. The rain has also made progress difficult in the cuttings for the shifting of the railway track.

THE Quetta extension of the South Peshin Railway was opened for traffic about Nov. 1, says the *Indian Engineer*. This is a line made to avoid the breaks in gauges on the Bolan Pass railway in India. Strange as it sounds the engineers and workmen suffered greatly during its construction from the intense cold, especially while working on the bridge near Sharigh, which is 5,500 ft. above the sea.

PANAMA advices of Nov. 6 say that the SOTO-CAROZO protocol for a treaty between Costa Rica and Nicaragua has been rejected by the latter State. This is claimed to interfere to a certain extent with the Nicaragua canal interest; and the jealousy of the two States owing the land traversed by the canal, the political ambition of some of the leaders and the mercenary motives of others, are at the bottom of this disagreement. But President STOUT, of the Nicaragua Canal Co., says that this disagreement is of some standing in time, and as the final surveys, yet to be made, may avoid Costa Rican territory altogether, the canal interests are not materially effected.

JOS. JOUET, E. SURGI and J. ROY, civil engineers and contractors, have just submitted a plan to the city authorities of New Orleans for the drainage of that city. They propose to enclose the city in strong levees and divide it into two nearly equal sections by a large canal receiving all the water carried by present canals. This canal would connect with the Mississippi at Carrolton, with a lock, and with Lake Pontchartrain, and empty into Lake Borgne. It would be about 20 miles long, 125 ft. wide and 8 ft. deep; it would drain into Lake Borgne by the difference in sea-level, and be flushed from the Mississippi and Lake Pontchartrain. The estimate of cost is $2,500,000. The ordinary tide level of Lake Borgne is 15 ft. below ordinary high water in the river, and 2½ ft. below the average city level. Drainage wheels would assist in the circulation of the water, and the main canal would be open to navigation for light draught vessels.

BALED sawdust is the latest output of a Maine sawmill. It is put up in neat half-cord packages enclosed in burlaps. A powerful hydraulic press does the work, and it is shipped to Boston street railway companies, where it is used instead of straw for bedding horses, and also to grocers and liquor dealers for packing. The cost of transportation is reduced more than one-half as compared with the saw-dust in bulk. Maine alone supplies 600,000,000 ft. B. M. of lumber annually, and as one-sixth of this is turned into sawdust, the supply is abundant.

AN Austrian engineer, Herr LEINWATER, has patented a new kind of light railway. The rails require no sleepers, but rest directly upon the ground on a 6 in. base, and they are only 1½ in. high with three grooves on the surface corresponding with three corrugations on the wheel. The London *Railway News* says this rail weighs "5 kilos per running mile," but 11 lbs. per foot or yard would read better. The car to be used weighs only 770 lbs. and will carry 12,430 lbs. The cost of a railway on this plan is stated at $400 to $500 per mile.

PUBLICATIONS RECEIVED.

A Hand-book for Steam Users, being rules for engine drivers and boiler attendants, with notes on steam engine and boiler management, and steam boiler explosions. By M. POWIS BALE, M. I. M. E., A. M. I. C. E. Longmans, Green & Co., London and New York, 1887. 4¾ × 7¼ in., 91 pp. 4 tables.

It is rather a pity to put such reading matter as this book contains in so neat and expensive a binding. The author states in his preface that the origin of the book was a chart of rules for engine-drivers to hang in engine-rooms. This he has enlarged and revised to constitute the first chapter of this treatise. The second chapter on boilers, and the third on engines are general dissertations, in which, by way of filling, is inserted a considerable part of the first chapter. In the fourth and last chapter on boiler explosions some of the matter in the preceding chapters pertinent to the subject is again worked in. The effect upon the reader who peruses the work from beginning to end is similar to that produced by traveling in a circle. The technical matter in the book is wholly of the "practical" sort, and will hardly interest professional men, though if it were properly arranged and written up it might be of some interest to mechanics, and as most of it is sound doctrine would probably do them no particular harm.

A thoroughly inexcusable fault is the exceedingly careless manner in which the book is written. We have space for two extracts which speak for themselves: "In putting patches on any part of a boiler never cut a hole out with square corners like the inside of a picture."—"Collapse [of boiler flues] arises in some cases from a partial vacuum within the boiler forcing down the top and sides of the flue."

In a paragraph on combustion the author makes considerable mention of "fluid carbon" which will probably surprise those scientists who have hitherto contended that carbon was infusible. Generally, however, the author's heresies are of a mild and innocuous type, and he does not often get beyond his depth in fluid carbon. Good technical works are none too "numerous" but they have had no increase by the publication of this volume.

The Railways of Brazil. A statistical article. Reprinted from the *Railway Age*, with notes and additions by JOHN C. BRANNER, Ph. D., Chicago. Railway Age Pub. Co., 1887. Pamphlet, 6 × 9¼ in., 26 pp. With maps and tables.

This is a short description of the existing Brazilian railway systems and the prospects which the country offers to new railroad promoters, capitalists and engineers. On the whole the outlook is not shown to be very promising.

Proceedings of the Michigan Engineering Society, for the 7th and 8th conventions of 1886 and 1887. Price, $1.00. H. D. BARTHOLOMEW, Secretary, Lansing, Mich.

This is a complete record of the business proceedings of the two conventions, and contains the following papers and the discussions upon them:—"Plats," by H. D. Bartholomew; "The Lands We Survey," by Geo. E. Steele; "Subterranean Surveying," by H. B. Sturtevant; "Report on the Tamarack Mine," by C. D. Lawton; "River Crossings for Water Mains," by W. R. Coats; "Thatcher's Slide Rule," by Prof. J. B. Davis; "A Land Case in our Supreme Court," by F. Hodgman; "The Engineer, his Position and his Duties," by Mr. Watkins; "Standard Bridges," by E. Treadwell; "The City Surveyor, his Uses and Abuses," by H. G. Rothwell; "Standard Measure," by Prof. J. B. Davis; "The Maintenance of Track and the Rail Saw," by W. L. Clement.

Stone Arches

With the rapid introduction of iron for bridge work very little has been effected in America in the way of studying the correct forms of brick and stone arches. Correctly speaking, except for uniform loading such as that produced by a canal or aqueduct, a stone or brick arch is unsuited to carry a moving load, for if in equilibrium when unloaded, then it is impossible for the same arch to be in equilibrium when unevenly loaded. Here, of course, we must be understood as referring to a linear rib of no depth. Arches are, in actual every day work, so constructed that within the two lines forming the intrados and extrados of the arch a variety of linear ribs may be drawn suited to an equal variety of loads and, to use RANKINE'S words, an arch is in equilibrium for any load when the linear arch or curve of equilibrium for that load lies within the middle third of the thickness of the arch ring. There is always great uncertainty in the calculation of arches of masonry, and RANKINE himself does not appear to believe much in anything except the proportions of stone arches which have stood the test of time, and he deduces an empirical formula from the proportions thus found which he recommends as giving minima dimensions. In practice when arches of large rise are built, the circular form is almost universal, and for flatter arches the ellipse is often employed. Both these forms are more or less incorrect on simple principles. For the circular arch the correct form is most usually the catenarian—a form deduced by transformation from the true catenary; for the elliptic or false elliptic arch, there is similarly a transformed hydrostatic arch which is truer in principle than the circle. In RANKINE'S works may be found several rather in-

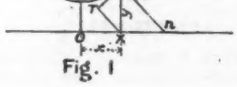


Fig. 1

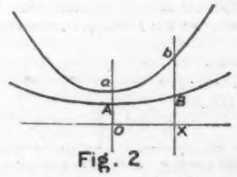


Fig. 2

volved and scattered explanations of the design of catenarian ribs, but they are rather of a nature to repel the practical engineer than otherwise. Hence in these days of substitution of stone for iron, as being carried out in certain localities, it may not be out of the way to inquire into the subject, for though we are of the opinion that stone arches are durable chiefly on account of the immense surplus of material used in their construction, and that equally strong and extravagantly built iron bridges would be equally long lived, we are prepared to admit that in appearance a stone arch lends itself better to tasteful design than any material which requires painting. In dealing with the problem of the stone arch as designed from transformation of the curve of a suspended chain, we must know first the elements of the catenary. These we may well take on trust from the mathematicians, and in Fig. 1 we may suppose a chain hung as shown. Then taking any point B, in the curve, it can be shown that the following equations hold good when the distance $o\,a$ of the vertex of the curve from a certain horizontal line is the modulus or parameter of the curve. B is situated a distance x horizontally and a distance y vertically from the origin o, and $o\,a$, the modulus will be designated by the symbol m. Then

$$y = \frac{m}{2}\left(e^{\frac{x}{m}} + e^{-\frac{x}{m}}\right)$$ where e is the base of the hyperbolic logarithm.

$$\text{The length of arc } a\,B = \frac{r}{2}\left(e^{\frac{x}{m}} - e^{-\frac{x}{m}}\right) = \sqrt{y^2 - m^2}$$

$$x = m.\ hyp.\ log.\left(\frac{y}{m} + \sqrt{\frac{y^2}{m^2} - 1.}\right)$$

The radius of curvature at B is $\frac{y^2}{m}$ and at $a = m$.

Making $X\,T = o\,a$ and the angle at $T = 90°$; also the angle $T\,B\,n = 90°$, we have $T\,B$ = arc $a\,B$ and $T\,B$ is tangent to point B. $B\,n$ = radius at B. RANKINE then goes on to state that if p be the weight of a foot of chain the horizontal tension at o will be $p\,m$, or simply the line $o\,a$ represents the horizontal tension, and $p\,y$ similarly is the tension at B. Hence the ordinate at any point represents a length of chain whose weight equals the tension at that point. To so transform a catenary as to be a linear rib for sustaining other than its own weight, it is necessary to vary its vertical ordinates whilst the horizontal ordinates remain unchanged.

In Fig 2 the lower curve may be taken as representing an actual arch inverted. Here the roadway is represented by the horizontal $O\,X$ and the curve is in equilibrium when loaded everywhere by a load which may be represented by the area $O\,A\,B\,X$. In a practical case we should have given the road level $O\,X$ and the crown of the arch at a distance $O\,A$ below the roadway. Also the springing point B would be known, and from these data the arch would be designed. Let us suppose a span of 40 ft., a height from roadway to intrados of 4 ft. and a rise of arch of 8 ft. Then in Fig. 2, $O\,A$ would be 4 ft; $X\,B$ would be 12 ft. and $O\,X = 20$ ft. We must first determine the modulus of the catenary from which we must derive our arch curve $A\,B$. This modulus is to be obtained from the formula

$$m = \frac{x}{hyp.\ log.\left(\frac{b}{y} + \sqrt{\frac{b^2}{y^2} - 1}\right)}$$ where $y = O\,A$ and $b = B\,X$ or $y = 4$ ft. and $b = 12$ ft. and $x = O\,X$ = the half span or 20 ft. Working this out we have

$$m = \frac{20}{hyp.\ log.\left(\frac{12}{4} + \sqrt{8}\right)} = \frac{20}{hyp.\ log\ 582}$$

Therefore $m = 11.355 = o\,a$, and we have given $O\,A = 4$ ft. Therefore we must alter all the vertical ordinates of the true catenary in the ratio $\frac{4}{11.355}$. To construct the arch curve then may be readily done by means of a calculated table of ordinates such as given by RANKINE, and here reproduced. It accords with Fig. 1, and is applicable to our illustration, Fig. 3.

$\frac{x}{m}$	$\frac{y}{o\,a}$
.0	1.0
.2	1.02
.4	1.081
.6	1.1854
.8	1.3373
1.0	1.5431
1.2	1.8106
1.4	2.1509
1.6	2.5774
1.8	3.1074
2.0	3.7622
2.2	4.5679
2.4	5.5569
2.6	6.7690
2.8	8.2526
3.0	10.0676

In the first plan, divide the span of 20 ft. into divisions such that the various distances from mid span may give the fractions under the head $\frac{x}{m}$ of the table. Now $m = 11.355$. Therefore, for $\frac{x}{m} = o$ we have $x = o$, for $\frac{x}{m} = .2$ we have $x = 11.355 \times .2 = 2.271$ and so on, the greatest value of the fraction being at the springing and equal $\frac{20}{11.355}$ or 1.761.

Opposite each such division of x is to be set off the corresponding length y from the horizontal line downwards. For the first value of $x = o$ we find of course $\frac{y}{o\,a} = 1$, *i.e.* the depth below the horizontal is the given depth 4 ft. The other ordinates are as follows:

For $\frac{x}{m} = .2$ $x = 2.271$ and $\frac{y}{o\,a} = 4 \times 1.02 = 4.08$
" " .4, $x = 4.542$ " " $= 4 \times 1.081 = 4.324$.
" " .6, $x = 6.813$ " " $= 4 \times 1.1854 = 4.7416$.
" " .8, $x = 9.084$ " " $= 4 \times 1.3373 = 5.3492$.
" " 1.0, $x = 11.355$ " " $= 4 \times 1.5431 = 6.1724$.
" " 1.2, $x = 13.626$ " " $= 4 \times 1.8106 = 7.2424$.
" " 1.4, $x = 15.897$ " " $= 4 \times 2.1509 = 8.6036$.
" " 1.6, $x = 18.168$ " " $= 4 \times 2.5174 = 10.3096$.
" " 1.8, $x = 20.439$ " " $= 4 \times 3.1074 = 12.4296$.

the last value being past the springing and not required. These values of the true catenary being determined the curve may be drawn through the points found, when being turned upside down we obtain Fig. 3, the arch under thrust in place of the chain under tension; the thrust at the crown being $wm^2 = 11.355^2 \times w$ where w is the weight per cube foot of the whole arch structure allowing for spandril voids if any. Taking w at 100 lbs. per foot, we have practically 12,800 lbs. as the thrust on each foot of breadth of arch stone, or something over 1,000 lbs. per inch of breadth. A common keystone depth for such an arch would be 30 ins., so that the unit pressure is only about 36 lbs. per sq. in. against an ultimate strength of granite of something like 7,300

The Weather of the United States for the Month of October, 1887.

[As respects the elements of most interest to engineers.]
According to special returns from the Chief Signal Officer of the U. S. Army.

STATION.	Temperature. Degrees Fah.				Wind Velocity. Miles per hour.			Precipitation. Rain and melted snow. Inches.		
	Average	Max.	Min.	Range.	Average	Max.	Direction. Max.	Total.	Hardest in 24 hours.	No. rainy days.
Northern Cities.										
Northfield, Vt.	43.4	70.1	18.6	51.5	6.4	45	SW	1.47	0.70	16
Portland, Me.	47.7	69.3	27.9	41.4	7.2	36	S	2.47	0.87	10
New York City.	54.7	63.1	47.9	65.2	8.9	26	NW	2.36	1.83	9
Pittsburg, Pa.	53.0	80.3	30.0	50.3	7.5	40	SW	0.39	1.20	6
Chicago, Ill.	47.3	82.0	14.2	67.8	11.3	48	W	2.03	0.82	8
Omaha, Neb.	50.7	81.0	15.8	65.2	8.7	30	NSW&NW	0.72	0.69	3
St. Paul, Minn.	42.3	73.4	11.5	60.9	6.5	35	NW	1.48	0.71	7
Duluth, Minn.	41.0	64 6	7.6	57.0	7.9	40	NW	3.94	1.57	10
Bismarck, Dak.	40.7	73.1	1.8	71.3	10.4	48	NW	1.15	0.53	11
Average	46.8	72.9	18.4	54.5	8.2	38.7		1.71	.88	8.9
Southern Cities.										
Washington City.	55.4	85.2	30.9	54 3	5.5	24	N & NW	1.82	1 14	11
Louisville, Ky.	55.5	84.0	25.5	58.5	7.6	32	W	0.39	0.24	5
St. Louis, Mo.	54.4	86.5	24.0	62.5	10.9	54	S	0.76	0.58	5
Savannah, Ga.	65.5	85.0	41.8	43.2	7.1	30	NE	4.13	1.20	8
Leavenworth, Kan.	52.6	89.3	23.0	66.3	6.8	27	S	3.87	3.10	6
Jacksonville, Fla.	70.1	87.9	40.0	47.9	7.8	34	SW	1.57	0.66	14
Chattanooga, Tenn.	57.8	83.6	32.3	51.3	5.5	25	N	3.41	1.36	7
New Orleans, La.	68.1	86.0	41.8	44.2	9.6	42	N	4.71	2.19	7
Memphis, Tenn.	60.2	88.0	32.6	55.4	6.6	32	NW	2.25	1.81	5
Palestine, Tex.	63.9	87.3	38.7	48.6	9.1	36	NE	3.20	2.60	5
Average	60.4	86.3	31.1	53.2	7.65	33.6		2.61	1.49	7.3
Far Western Cities.										
Helena, Mont.	42.9	74.2	2.7	71.5	7.2	35	SW	1.01	0.44	7
Fort Angeles, W. T.	46.0	62.7	29.1	33.6	4.0	30	W	2.89	1.37	15
San Francisco, Cal.	62.9	87	49.2	37.8	7.7	34	W & N	*—	*—	0
Salt Lake City, U.	52.5	85.2	27.5	57.7	4.6	27	NW	0.30	0.30	1
Denver, Col.	48.2	85.1	7.8	77.3	5.6	42	NW	0.97	0.56	12
Yuma, Ariz.	75.8	107.5	47.9	59.6	5.8	32	NW	0.02	0.02	1
Santa Fé, N. M.	50.6	78.0	31.0	47.0	10.7	24	N & S	1.50	1.04	4
Average	54.1	82.3	27.9	54.9	6.65	32.		.96	.52	5.7

*Trace

lbs., equivalent to a nominal factor of safety of 200. This of course is for the unloaded arch; for a heavy train load of 3,000 lbs. per foot the arch pressure would be only 75,000, so that for a breadth of 6 ft. it could not more than double the dead load pressure and reduce to a nominal factor of 100. What the actual stresses would be as the train advanced upon the structure it is difficult to exactly determine, but it is certain that they would be very different, and hence it

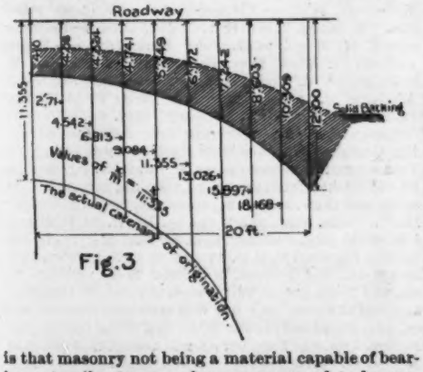


Fig. 3

is that masonry not being a material capable of bearing a tensile stress, arches are supposed to be constructed of such depth that an equilibrated rib could be drawn for every position of load that would fall well within the body of the arch ring. In practice, however, the amount of backing is so great that it is probable the arch ring itself might be frequently removed, and yet the structure would stand: Even in stone arches the structures are little other than abutting cantilevers. If it is desired then to construct an arch on the principles of the transformed catenary, all that is necessary after knowing the data as to rise, span and crown depth from roadway, is to calculate the modulus and work out the curve, and in actual construction to so arrange the spandril filling, if not solid, that over each portion of the arch there shall be a weight proportionate to the depth of intrados below the roadway, which is the "directrix" of the curve. This is easily assured by making the solid backing an equal fraction throughout of the total depth y and by preserving a uniform thickness of spandril walling. So constructed, the arch is in perfect unloaded equilibrio, and when loaded is certainly no worse off than any other form of arch. Like the parabolic arch, which it closely resembles, the catenarian curve gives a greater flatness to the arch ring at the haunches than does the true circle, but, properly designed, has not an unpleasing appearance.

Large arched ribs of iron for station roofs have been erected in England on this principle of obtaining a true equilibrated structure under its own weight, notably in the case of the St. Enoch Station at Glasgow, or of the still larger Central Station in Manchester. In both these cases spans of about 200 ft. are covered by arch roofs of about 100 ft. rise, and the peculiar curve of the ribs is very noticeable from the outside.

It is necessary to understand, when designing arches, that there is an essential difference between an arch of masonry and an arch of metal. In the metallic arched rib when an uneven load is applied it may be shown that the curve of equilibrium for such load lies outside the linear rib for even loading, and the amount by which the two curves depart from each other, as measured by the intercept of a vertical line at any point, is the measure of the bending stress in the rib due to the dissimilarity of the two curves. Hence, every metallic rib, properly constructed, bears the loading upon it partly as a thrust and partly as a bending moment, and metallic ribs may therefore be calculated as though horizontal beams, in a sense, as well as arch ribs. The case is very different with the masonry arch, for masonry is not considered suitable to bear a stress of tension anywhere, and to act as a horizontal beam with lower side in tension is, if not altogether beyond the capacity of good masonry, at least beyond engineering allowances for it. Thus it is that any deviation of the curve of pressures from the curve of the rib must not be greater than can be contained within the arch ring, and good practice has found this deviation within the middle third of the arch ring thickness, though absolute safety is not sacrificed even when the deviation extends too close upon the edges of the ring stones. Such, however, is not advisable, and from this point alone may be gathered perhaps the main cause of masonry arches requiring for safety so large a surplus of material. With even loads, as in the case of a canal or other aqueduct, a carefully calculated catenarian arch should be capable of being constructed to very much lighter proportions than are usually adopted, always provided, of course, that abutments are firm and unyielding, without which no stone arch should be constructed.

We propose to treat in a similar manner upon arches of other curvatures in a future issue.

CONSTRUCTION NEWS.

Water.

Camden, N. Y.—The Board of Village Trustees have granted a franchise to MINER P. OSBORNE, giving him the exclusive right to conduct an electric light plant within the village, for 5 years from January 1., work to be commenced within 3 months and completed within 6 months from date. Mr. OSBORNE has obtained subscriptions sufficient to warrant the outlay. The franchise is non-transferable and it is understood that the plant will be owned and operated by local capitalists, who will form a company for the purpose.

The Driven Well Patent.—Washington despatches of Nov. 14, say that Justice BLATCHFORD, of the U. S. Supreme Court, has declared the driven well patent invalid, as the invention was used in public at Cortland, N. Y., by others than GREEN more than 2 years before application for patent was made. The decree, of the U. S. Circuit Court for the Southern District of Iowa, in ANDREW GREEN *vs.* GEORGE HOVEY, is affirmed in favor of the alleged infringer HOVEY.

Bismarck Dak.—On Nov. 12, the new water-works were completed and put in operation, the water being turned on with some ceremony. Messrs. ALEX. MCKENZIE, E. H. BLY and R. B. MELLON, who were instrumental in securing the establishment of the works, together with COL. MONROE, the engineer, and Mr. DANAHER, the contractor, were universally congratulated.

Weatherford, Tex.—

DALLAS, TEX., Nov. 10, 1887.

EDITOR ENGINEERING NEWS:

The Weatherford Water, Light & Ice Co. has been incorporated by J. R. LABATH, HENRY WARREN, and associates. Mr. W. R. FREEMAN, a well known hydraulic engineer of San Antonio, Tex., is busy preparing plans for the works. Weatherford is a rapidly growing town of 5,000 people, the county seat of Parker county, and at the junction of the Gulf, Colorado & Santa Fé Ry. with the Texas & Pacific Ry.

W. J. SHERMAN,
Chief Engineer, G. C. & S. F. Ry.

New Water-Works.—*Massachusetts.*—Amherst. The Amherst Water Co. has completed the repairs to the dam at Pelham. A new gate house has been built.——Great Barrington. The Berkshire Heights Water Co. has completed its dam at the Green river bridge, and the reservoir on the heights, with a capacity of 1,000,000 galls., will soon be filled by the pumps.

Rhode Island.—Bristol and Warren. The Kickemuit Water-Works Co. is extending its system in both towns. The water is of excellent quality, and the company is a financial success.

Connecticut.—Mystic. Water-works are in contemplation, but no definite arrangements have yet been made.

New York.—Geneva. The water company has made connection with the new system of mains.——Syracuse. The water question is again being agitated, and the Syracuse & Salmon River Water Co., in which WM. A. SWEET is interested, is expected to get a franchise; the proposed terms are $50 per hydrant.

District of Columbia.—Washington. The work on the extension of the water-works is nearly completed and ready for final acceptance, according to Major LYDECKER's report. It is expected that the reservoir work will be completed this month, and a final settlement made with the contractors.

Maryland.—Salisbury. Address the mayor for particulars of the proposed water-works.

West Virginia.—Grafton. Plans and specifications for the new works will be prepared by HENRY S. WILSON.

Kentucky.—Owensboro. The council will take action as to the acceptance of the new water-works at its meeting on Nov. 21.

Georgia.—Rome. A company with a capital stock of $100,000 is to be organized to buy the water-works. Address J. W. ROUNSAVILLE.——Macon. The extension of the mains is nearly completed. The work is in charge of Capt. WILCOX, the Superintendent.

South Carolina.—A proposition to build water-works and establish an electric light plant, has been made by JULIUS H. HOWARD.

Michigan.—Gaylord. A system of water-works is contemplated; to cost about $10,000. The question was voted on Nov. 15.

Illinois.—Bunker Hill. The proposition to build water-works was considered by the City Council Nov. 15.——Staunton. The Board of Trustees have ordered a vote for Dec. 15, on the issue of bonds for $6,000 water-works.——Pittsfield. Work was commenced Nov. 9 on the trenching and pipe laying for the new works.——Sullivan. The city has voted bonds for $35,000 for new water-works; the supply will be drawn from the well of the old works.——Centralia. Water-works are to be constructed and a committee has been appointed to

correspond with water companies, B. HAUSSLER is Mayor.

Minnesota.—Albert Lea. A company has offered to build water-works at a cost of about $25,000, if the city will grant an exclusive franchise for 30 years.

Missouri.—St. Joseph. Water was turned into the third reservoir Nov. 7; the water company has now fulfilled its contracts with the city. The reservoir is 300 ft. long, 200 ft. wide and 20 ft. deep; it has a capacity of 16,000,000 galls.

Kansas.—Concordia. Water-works are to be put in shortly.——Huntington. A system of water-works, to cost about $125,000, is contemplated.

Arkansas.—Marianna. The contract for the new water-works has been awarded. For information address B. M. BARRINGTON.

Colorado.—Red Cliff. The water-works have been completed.

California.—Templeton. The water-works have been completed. The water is pumped to a distributing reservoir.

Texas.—Galveston. The experiments for developing water supply from the 421 ft. well have been abandoned, and the well will be driven deeper.——Sherman. A contract has been signed between E. SUTPHIN and the city, by which the former is to furnish a supply of 1,000,000 galls. or receive no pay. The contract price, if he is successful, is $33,000.——Cross Roads. A system of water-works will be put in by BRYAN T. BARRY, of Corsicana.—Greenville. The City Council will probably advertise for new bids for the construction of the water-works.

Mexico.—Guaymas. It is reported that an English syndicate has been organized to supply the city with water under favorable concessions from the Governor of Sonora.

Rochester, N. Y.—Important changes have been made in the arrangement of the water mains leading from Rush reservoir to the city. For the purpose of making required repairs to Mt. Hope reservoir and to the gates controlling the flow of water to and from it, the water in the reservoir might require lowering, and possibly entire removal. In order to do this, if required and yet not interfere with the daily city service, Chief Engineer TUBBS conceived the plan of intercepting the supply from the Rush reservoir in the conduit pipe at some point west of the city reservoir, and by connections with the large mains which supply the city directly, effect the daily service from Rush. To do this the 16-in. main which feeds the West side of the city was first cut and by a series of curved specials depressed under the 24-in. lateral from the conduit to the north. A line of 20-in. pipe with necessary specials was placed parallel to the main conduit line and connected to it and the 15-in. line by proper pipe and specials. The 20-in. line which afterwards—decreased to 16-in.—supplies the east side, was then connected with the 24-in. extension, and its former alignment changed to conform to the new construction. Five new stop-gates, one 24-in., three 20-in., and one 16-in., have been placed in such positions that the supply may be passed to the feed mains or to one of them directly from the city reservoir; or to one or both directly from the Rush reservoir, as occasion may require, and Mount Hope reservoir may be drained off without interfering in the least with the city's wants.

Proposals Open.

Artesian Well.—WM. M. SPITLER, City Secretary, Burnet, Tex.

Street Work.—Grading, curbing and paving. A. E. SMYRK, City Commissioner, Baltimore, Md. Nov. 21.

Terra-Cotta Pipe.—EDWARD CLARK, Architect of the Capitol, 145 E. Capitol street, Washington, D. C. Nov. 21.

Inlet Crib.—Inlet crib and pier at Quindaro water-works station on the Missouri river; plans and specifications prepared by the Chief Engineer. B. F. JONES, Superintendent. National Water-Works Co., Kansas City, Mo. Nov. 22.

Bridge Substructure.—Substructure for iron foot bridge over the Des Peres river, in Forest Park. HENRY FLAD, President, Board of Public Improvements, St. Louis, Mo. Nov. 22.

Street Work.—Oblong granite block paving, 700 sq. yds. JOHN HUNKELE, Street Commissioner, Newark, N. J. Nov. 22.

Trenching and Concrete.—Trench excavations and concrete foundations for the U. S. Court House at San Antonio, Tex. WILL. A. FRERET, Supervising Architect, Treasury Department, Washington, D. C. Nov. 28.

Sewers.—THE COMMISSIONER OF PUBLIC WORKS, 31 Chambers street, New York City. Nov. 28.

Boilers, Duplex Pump, Boiler House, Water Tower, Buildings, Etc.—At Islip, L. I. THE DEPARTMENT OF PUBLIC CHARITIES AND CORRECTION, 66 Third avenue, New York City. Nov. 29.

Steam Heating Etc.—For pavilion at Randall's island. THE DEPARTMENT OF PUBLIC CHARITIES AND CORRECTION, 66 Third avenue, New York City. Nov. 29.

Dredging.—In Mott Haven canal; 15,443 cu. yds. of mud and deposit. Extension of time. JAMES C. BAYLES, President, Health Department, 301 Mott street, New York City. Dec. 1.

Crib Bulkhead and Dredging.—Crib bulkhead at the foot of W. 158th street, North river; and 9,000 cu. yds. of dredging. The DOCKS COMMISSIONERS, Pier A., North river, New York City. Dec. 1.

Water Pipe.—Furnishing and laying 6-in. water pipe from St. Louis to Jefferson Barracks, Mo. C. W. FOSTER, Depot Q. M., U. S. A., St. Louis, Mo. Dec. 8.

Contracting.

Dredge.—The Commissioners of Hennepin county, Minneapolis, Minn., have authorized the committee on Lake Minnetonka improvements to procure a new dredge boat.

The King Iron Bridge & Manufacturing Co., of Cleveland, O., is purchasing machinery to equip the new shops which will be completed in a short time.

Concrete.—The contract for trenching and concrete for the foundations of the addition to the new Post Office at Brooklyn, N. Y., has been awarded to John Cox & Co., of Brooklyn, for $5,646.72.

Fire Engines.—The Silsby Manufacturing Co., of Seneca Falls, N. Y., has been awarded a contract for two No. 2 steam fire engines for Syracuse, N. Y.

Dumping Cars Wanted.—The Barataria Canning Co., of Biloxi, Miss., is in want of a number of dumping cars.

Railroad Supplies.—A syndicate of eastern capitalists is proposing to build extensive works for the manufacture of steel tubular cars and general railroad supplies near McKeesport, Pa. Mr. CHARLES A. ARNE, of Boston, is interested.

Wooden Pier.—The following proposals for building a wooden pier at the foot of W. 32nd street have been received by the Docks Commissioners, New York City: Ranald Gillies, $66,0.0; Joseph Walsh, $71,000; P. Sanford Ross, $74,000. The contract was awarded to Ranald Gillies.

Dredging.—Wm. Upham & Co. have a contract for dredging in the St. Louis river at Duluth, Minn., near the bridge of the St. Paul & Duluth R. R. The contract price is $20,000, and the work is to be completed this season.

Electric Light in the Hoosac Tunnel.—The Fitchburg R. R. Co. has awarded the contract for lighting the Hoosac tunnel to the Westinghouse Electric Light Co. There will be about 1,200 lights.

Water-Works.—Mr. JOHN W. HILL, Mechanical Engineer, Room 21 Glenn Building, Cincinnati, O., expects to let contracts for water-works as follows: Franklin, O., $45,000, during the present year; Findlay, O., $270,000, during the winter; Clarksburg, W. Va., $50,000, in January; Sidney, O., $80,000 for improvements, and Bellefontaine, O., $45,000 for improvements, next season. Proposals are now open for the Findlay works (see first cover page).

A High Range of Prices. The proposals opened by the Road Committee, Montreal, Canada, for the construction of the Mignonne street sewer, showed a very great difference in prices: 12-in. tile pipe ranged from $3.25 to $6.50 per lin. yd.; concrete from 40 cts. to $4 per cu. yd.; manhole shafting from $3 to $22 per lin yd.; and lamphole from $1.20 to $5 per lin. yd.

H. K. Porter & Co., of Pittsburg, Pa., manufacturers of light locomotives, have at their works an engine for a 30-in. gauge mining road in Mexico, a double ender passenger engine for California, and street motors for Wichita, Memphis and Butte City. They have now under way narrow gauge locomotives for Ecuador and San Domingo, besides a number of logging, mining and shifting engines ranging from 5 to 30 tons in weight.

Roofing and Copper Work.—The following proposals for roofing and copper work for the high service pumping station at Chestnut Hill reservoir, Boston, Mass., were received Nov. 14, by the Water Board: Roofing: John Farquahar & Sons, $4,000; George Martin, $4,274; E. Marley & Bros., $4,300; W. J. Maguire, $4,525; C. J. Parker & Son, $4,765; J. Harrigan & Son, $5,100.——Copper work: E. Marley & Bros., $1,993; E. B. Badger & Son, $1,695; E. Van Noorden, $1,993; F. H. Holton & Co., $2,700.

Water Supply, Sewerage, Etc.—The Board of County Supervisors, at the County Court House, Brooklyn, N. Y., on Nov. 15, opened the bids for the work at the county farm, St. Johnland, L. I., as mentioned on page 357. There were five bids received, but as they were all itemized prices and gave no totals they were referred to the Contracts Committee to determine which is the lowest bid. The bidder were: John H. O'Rourke, Cranford & Valentine, James W. Birkett, Edward Freel and Ryan & McDonald. The estimate of ENGINEER CAREY is $360,000.

Substructure for Foot Bridge.—The Board of Public Improvements, St. Louis, Mo., rejected all the bids received Nov. 7 for the substructure for the iron foot bridge over the river Des Peres, in Forest Park, and has readvertised. Proposals will be received until Nov. 22.

Crib Breakwater.—The following proposals for the crib breakwater were opened Nov. 14, by Mr. GEO. B. SWIFT, Commissioner of Public Works, Chicago, Ill.: Fitz Simons & Connell, $119,000; H. B. Herr, $119,000; Chicago Dredging & Dock Co., $129,000. It was not decided which of the first two bids should be accepted.

New Croton Aqueduct.—The Aqueduct Commissioners, New York City, opened the proposals Nov. 16, for the construction of the gate-houses at Yonkers and Pocantico, but the contracts were not awarded. The bids were as follows: Yonkers; O'Brien & Clark, $20,935; John Pierce, $22,160.50; Thomas Dobbin, $22,836.20.——Pocantico; John Pierce, $22,410.50; Thomas Dobbin, $25,912.50; Brown, Howard & Co., $24,719.50.

Chicago Water-Works Tunnel.—The following proposals for the construction of the new water tunnel at Chicago, Ill., were opened Nov. 14 by Mayor ROCHE and Commissioner of Public Works SWIFT: A. Onderdonk, of New York, $748,500; M. P. Garrity, $800,628; E. Earnshaw, $823,161; Simons & Connell, $887,490; McAdams & Amberg, $1,107,160; Angus & Robinson, $1,145,175. The contract was awarded to Mr. Onderdonk. The Chicago *Tribune* says:

"Andrew Onderdonk is a civil engineer of experience who has his headquarters at New York City. He has done his most noteworthy work in Canada, California, and British North America, and is well known to the heavy financiers and leading engineers of those parts of the country. One of his biggest undertakings was the building of the western 350 miles of the Canadian Pacific from the Rocky Mountains to the Pacific Ocean. There were over 40 tunnels in this part of the line, and his work was considered by the best authorities as ranking with the most difficult and scientific ever done on this continent. One of his contracts with the Canadian Pacific amounted to $9,000,000 and the smaller ones aggregated nearly as much. He built the harbor improvements of San Francisco, including the docks, ferry slips, and stone sea wall in deep water, and is an expert in submarine work. Financially he is entirely responsible, and his past work is a guarantee of his ability to successfully carry the new tunnel to completion."

The work was described in ENGINEERING NEWS, page 316.

Street Work. Brooklyn, N. Y.——The following proposals have been received for grading and cobblestone paving: Jefferson avenue, Harris & Maguire, $5.44 per lin. ft.; Henry Mogk, $4.89; Thomas Monahan, $3.45; Thomas McDonald, $3.27.—— Pulaski street, Charles Hart, $3.90; Thos. Monahan, $3.39; H. Mogk, $2.49; T. McDonald, $1.27.—— Evergreen avenue, Chas. Hart, $5.60; H. Mogk, $4.98; H A. Nolan, $3.29. ——Roebling street, H. Mogk, $4.83; John Hart, $4.50. —— Union avenue, H. Mogk, $4.98; Chas. Hart, $4.29.——Stockholm street, H. Mogk, $3.19.——Grove street, Harris & Maguire, $5.33; Thos. Monahan, $4.39; H. A. Nolan, $4.37; H. Mogk, $4.19; T. McDonald, $3.87.

Cincinnati, O.—The following proposals for improving Grand avenue has been received by the Board of Public Affairs: Broken stone, H. Sweeney, $1.55 per cu. yd.; E. Buckley, $1.75 per cu. yd.; coping, $3 50 and $4.20 50 cts. and 50 cts. per sq. ft.; crossings, 70 cts., 70 cts. per lin. ft.; curbs, 70 cts. and 70 cts. per lin. ft.; 24, 18, 12 and 6-in. drain pipe, Sweeney, $2.45, $2, $1.35 and 70 cts. per lin. ft.; Buckley, $3, $1.40, $1 and 40 cts.; gutters, $1.15 and 95 cts.; flag gutters, 70 cts. and 70 cts.; grading, 32 cts. and 28 cts. per cu. yd.; uncoursed rubble masonry, $4.15 and $4 per cu. yd.; dry wall masonry, $3 and $3 per cu. yd.; limestone paving, 70 cts. and 75 cts. per sq. yd.; rolling, 6 cts. and 5 cts. per sq. yd.; gravel; $2.25 and $2.25 per cu. yd.; inlet plates, 6 cts. and 5 cts. per lb.; total, H. Sweeney, $19,908.75; E. Buckley, $17,371.25. H. J. STANLEY is Chief Engineer of the Board of Public Affairs.

Madisonville, O.—The following proposals for improving Julian street were opened Nov. 5 by E. F. LAYMAN, C. E., 49 W. Third street, Cincinnati: Edward Sullivan, excavation, 23 cts. per cu. yd.; gravel, 90 cts. per cu. yd.; macadamizing, $1.80 per cu. yd.; paving gutters, 85 cts. per sq. yd.; total, $4,398.20. John Ryan, 25 cts., 95 cts., $1.90, 95 cts., $4,735. The contract was awarded to Edward Sullivan.

Kansas City, Mo.—The contract for grading on Prospect avenue has been awarded to Strong & Newcomb at the following prices: excavation, 21 cts. per cu. yd.; rubble masonry, $4.50 per cu. yd.; concrete, $3 per cu. yd.; 18-in. pipe, $1.25 per lin. ft.——The contract for curbing on Wyandotte street has been awarded to A. Keating at 69 cts. per lin. ft. for new curbing and 15 cts. for resetting.

St. Louis, Mo.—Contracts have been awarded as follows by the Board of Public Improvements: Reconstructing streets with pine blocks treated with chloride of zinc; J. Michel, $57,665 and $46,403.50; reconstructing streets with granite, Allen & Vieths, $21,273, $29,922, $18,281.50 and $29,231; Fred Skrainka, $9,868.40 and $22,124.70.

Water-Works.—The city of Galveston, Tex., will soon advertise for proposals for the new water-works. J. D. COOK will be Chief Engineer.

The Canadian Locomotive & Engine Works.—This company, at Kingston, Ont., has sold half its capital stock, $150,000, to Dübs & Co., of Glasgow, Scotland, who own one of the largest locomotive works in Great Britain. This firm will assume the management on Dec. 15, and will send out a superintendent, assistant superintendent and draughtsman from Scotland. It is also proposed to build iron steamships.

Structural Iron Work.—The following proposals for iron work for the federal building at Minneapolis, Minn., have been received by the supervising architect, Treasury Department, Washington, D. C.: Snead & Co, Iron Works, Louisville, Ky., $31,000; Haugh, Ketcham & Co., Indianapolis, Ind., $31,950; Marshall Foundry Co., Pittsburg, Pa., $32,985; Motherwell Iron & Steel Co., Logan, O., $33,276; Phœnix Iron Co., Philadelphia, Pa., $34,500.

Crib Bulkhead.—The following proposals for the construction of a crib bulkhead, with appurtenances, between E 114th and E 115th streets, Harlem river, have been received by the Docks Commissioners, New York City: John Gillies; dredging 30 cts. per cu. yd.; rip-rap stone, 65 cts. per cu. yd.; crib bulkhead complete, $5,500; Joseph Walsh, 35 cts., 45 cts., $8,500; John W. Flaherty, 35 cts., 80 cts., $4,375; P. Sanford Ross, 35 cts., 75 cts., $6,950. The contract was awarded to John Gillies.

Abutments.—The following proposals for the construction of the abutments and approaches to the Ship street canal bridge, have been received by J. SHANAHAN, Superintendent of Public Works, Albany, N. Y.: John Flood, Fort Edward, N. Y., $5,781.70; Malone & McKenna, Troy, N. Y., $6,492.50; Sherman & McDonough, Troy, N. Y., $6,709; M. Rockford, $7,112. The contract was not awarded, all the bids being beyond the appropriation.

An Alteneder Pen.— A "bow pen" recently came to the establishment of Theodore Alteneder, in Philadelphia, which Mr. Alteneder made and sold 35 years ago. The pen has been in constant service by the same person during all those years. While it lacks some of the improvements which similar instruments made at that place now have, it is a good, serviceable pen, and may easily last for 35 years longer. The Alteneder establishment is being gradually enlarged, but hardly enough to keep pace with the steadily growing demand for the standard instruments which it produces.

Excavation and Masonry.—The following proposals for the excavation of the race on the grounds of the new city water-works, and for building walls on each side of the stream about 300 ft., as well as masonry for the support of the water main across the stream, were received Nov. 11 by Mr. WM. A. MORTON, Mayor, Lancaster, Pa.: J. F. Stauffer, 25 cts. per cu. yd. for excavating, and $6.50 per perch for wall, including coping. John Hood, excavating and wall, $6.50 per perch. Licht & Kregel, $2,750 for the entire work. Kitch & Smith, 30 cts. per yd. for excavating and $4.90 per perch for walls, the coping, which is included, to be of Port Deposit granite. The contract was awarded to Kitch & Smith.

Asylum for the Insane.—The city of New York will spend about $60,000 in the erection of buildings and making improvements at Central Islip, L. I., where it is intended to locate the chronic insane. The items enumerated in the appropriation are as follows:

Clearing land and plowing	$ 774
Grading road	450
Water supply, engine and boiler, house and wells	10,000
Sewerage	2,800
Residences for 100 patients	13,500
Dining room, kitchen, bath and latrines	6,136
Superintendent's house	9,000
Stable, wagon, tool house, etc.	4,300
Storehouses	2,500
Plant, superintendence and contingencies	6,000

Proposals will be received till Nov. 29 by the Charities Commissioners, 66 Third avenue.

Estimates for the Lighthouse Service.—The Lighthouse Board has made estimates of appropriations for the lighthouse establishment during the next fiscal year as follows: Salaries, office of the Board, $36,340; supplies for lighthouses, $340,000; repairs of lighthouses, $350,000; salaries of keepers, $600,000; expenses of light vessels, $225,000; expenses of buoyage, $325,000; expenses of fog signals, $70,000; inspecting lights, $5,000; lighting of rivers, $250,000; survey of sites, $2,500; making a total for the lighthouse establishment of $2,107,500. Special estimates are made for new lighthouses aggregating $1,023,000, including for a lightship for the Sandy Hook station, $80,000, and for a light midway between Barnegat and Navesink, $90,000; and also for a suitable building at Washington for the use of the Lighthouse Board, $210,000.

Drainage at New Orleans.—No bids were received by the City Comptroller of New Orleans, La., for culverting the Camp street canal with brick, according to the specifications. Mr. T. Tupper offered, however, to furnish a sufficient number of vitrified pipe, with two manholes at each intersection, built of brick and set with cement, to carry off rainfall between Felicity and Erato to Melpomene canal, as fast as the culvert can convey it to the draining machine. The same to be so placed and constructed as to provide for extension of system. To perform by this means the same work as advertised for to be done in brick, $37,500.

Reservoir.—The following proposals for the construction of the new distributing reservoir at St. Paul, Minn., were opened Nov. 10 by the Board of Water Commissioners: McArthur Bros., of St. Paul, $97,547.15; J. D. Moran, of St. Paul, $114,000.50; Fruin Bambrick Construction Co., of St. Louis, Mo., $115,526.05; J. J. Palmer, of Minneapolis, Minn., $119,102.39. The contract was awarded to McArthur Bros. Work will be commenced next spring and will be completed by next October. The reservoir will be in the town of Rose, near the northerly part of the city of St. Paul; it will be partly in excavation and partly in embankment. The extreme dimensions from face to face of coping, will be 300 ft. by 500 ft. A list of quantities was given in ENGINEERING NEWS, Oct. 8 (p. 368). The Consulting Engineers are H. H. HARRISON, of St. Paul, and J. T. FANNING, of Minneapolis.

Sewers.—*Brooklyn, N. Y.*—The following proposals for sewers in Drainage District No. 29 have been received by the Commissioner of City Works: Daniel J. Crean, 12, 15 and 18-in. cement pipe, $1.05, $1.50 and $1.60 per lin. ft.; 30-in. brick sewer, $5.50 per lin. ft.; man holes, $40 each; street basins, $110 each. Wm. Weis, $1.08, $1.50 and $1.85, $4.50, $36, $95. John S. Bogart, $1.35 and $1.50, $4.50, $36, $109.

Syracuse, N. Y.—The new proposals for the 60-in. brick sewer on Croton and other streets to Onondaga creek were as follows: Martin, Sprague & Co., $28,070; Michael Dillon, $29,948; Patrick Ready, $30,768. The contract was awarded to Martin, Sprague & Co. There was a reduction of about $5,000 below the old bids.

Rochester, N. Y.—Contracts have been awarded as follows: Edward street pipe sewer; George Chambers, 12-in. sewer pipe and grading, $1.33 per lin. ft.; 4 surface sewers, $20; 12 Y-branches, $1.10; 5 lot laterals, $7; manhole, $35; total, $602.10.——Avenue A pipe sewer; F. C. Lauer's Sons, 95 cts., $16, $2, $7, $40, $415, for similar work.——Thomas Park pipe sewer; S. J. Wagoner, 96 cts., $13, 79 cts., $8, $34, $706.12 for similar work.——Caledonia avenue outlet sewer; Geo. Chambers, 15 and 18-in. sewer pipe, $5.39 and $6.26 per lin. ft.; main sewer stone, including grade, 3¼ ft. by 1¾ ft., $9.50 per lin. ft.; 11 surface sewers, new, without trap, complete, $30; 23 surface sewers repaired, $8; 4 pipe connections in stone sewer, 50 cts.; 13 Y-branches in pipe sewer, $1.50; 34 lot laterals, $25; 60 lot laterals repaired, $7; 10 manholes, $30; 1 lamphole, $10; total $24,224.15. The other bidders were, N. L. Brayer, $23,933; F. C. Lauer's Sons, $24,834; Wm. Fuller, $26,445.95; Wm. Dwyer, $27,448; Whitmore-Rauber & Vicinus, $27,972.92.

Newark, N. J.—Contracts for sewer basins have been awarded to B. M. & J. F. Shanley, P. H. Harrison and J. M. Wilkes.

Cincinnati, O.—The following were the proposals for the Noble Court sewer: H. Frank, 12-in. pipe, $1.65 per lin. ft.; Y-branches, .75 cts. each; round manholes, $36 each; oval manholes, $32 each; sheeting, $16 per 1,000 ft. B. M.; total, $1,340.50; J. A. Sullivan, $1.70, 75 cts., $31, $30, $18, $1,392.50; P. Gleason, $1.60, $1.50, $40, $35, $20, $1,443; Peter & Steele, $2, 80 cts., $46, $46, $22, $1,703.60; J. M. Peter, $2, 90 cts., $50, $45, $36, $1,787.80.——For the Rider alley sewer the only bid was from P. Gleason; 12-in. pipe, $1.95; Y-branches, $1.50; oval manholes, $40; sheeting, $20; total, $964.50.

Chattanooga, Tenn.—The following proposals have been received for the construction of 4 brick sewers; January, Cleary & Davidson, of Chicago, $8,000; W. P. White, of Chattanooga, $10,600. The contract was awarded to January, Cleary & Davidson for this work, and for a pipe sewer at $630. Pipe extensions will be built by the city.

Kansas City, Mo.—There were 5 bids for sewer district No. 43, and the contract has been awarded to John Shaw, the lowest bidder, at $37,199. There will be about 6 miles of sewers in the 160 acres of the district and City Engineer DONNELLY says it is the largest contract ever let from his office. The contract prices are as follows: brick sewers, 6-ft., $8 per lin. ft.; 62-in., $5.65; 60-in., $5.40; 56-in., $4.80; 52-in., $5; 50-in., $4.25; 48-in., $4.30; 44-in., $4.50; 38-in., $4.25; 34-in., $4; 30-in. and 28-in., $3.20; 24-in., $2.80; 15-in. pipe, $1.45 per lin. ft.; 15-in. pipe, $1.10; 12-in. pipe, $1; manholes, $45 each; catch basins, "B," $40 each; catch basins, "C," $35 each; rubble masonry, $5 per cu. yd.; cement concrete, $3.25 per cu. yd.; rock excavation, $3.80 per cu. yd.; lumber, $18 per 1,000 ft. B. M.; rip-rap, $1 per cu. yd.

Denver, Col.—New sewers are contemplated. The estimated cost of the new 31st sewer district is $125,000, about $29 per lot, and that of the new 10th sewer district is $40,000. The average cost of previously constructed sewers has been about $50 per lot. Plans and specifications have been prepared by the City Engineer.

San Diego, Cal.—Work is in progress on the sewer system, which will comprise 31,000 ft. of 6-in. to 24-in. sewer pipe. Contractor Johndrew receives 50 cts. per lin. ft. for trenching and backfilling, the pipe being laid by the city, and Contractor Dunn receives 95 cts. per ft. for trenching and backfilling and 10 cts. per ft. for laying pipe. Of the amount appropriated for the sewer system, of which bonds for $400,000 have been issued, $41,428.97 have been expended. The pipes convey the sewage to a large flush tank, whence it will be discharged into the bay at high tide.

RAILROADS.

East of Chicago.

Existing Roads.—*Cincinnati, Hamilton & Dayton.*—The order of Judge VANDEVEER appointing a receiver for this company has been reversed by the United States Circuit Court. GEO. K. DUCKWORTH, the plaintiff in the case, will appeal to the Supreme Court.

Ohio & Northwestern.—The change of gauge of the line from Cincinnati to Portsmouth has been completed.

Rome, Watertown & Ogdensburg.—The periodical rumor is again in circulation that the company is to obtain an entrance to Buffalo, N. Y., by the construction of the Lockport & Olcott road, about nine miles in length.

Fitchburg.—This road is now operated as a double track from Boston to Johnsonville, N. Y., 175 miles.

Old Colony.—The Easton and Matfield branch is almost completed.

Grand Trunk.—On the Beauharnois Junction road tracklaying is in progress beyond the Chateauguay river.

Somerset.—The annual meeting of this Maine company was held Nov. 11. About $20,000 has been expended on the extension from North Anson to Bingham, and the road is to be completed next year. It is intended ultimately to build on to a connection with the International road at the forks of the Kennebec river.

Chicago & Northwestern.—All work has stopped on the extension from Ishpeming to Michigamme, Mich., owing to a difficulty about the crossing of the Duluth, South Shore & Atlantic tracks near the latter point.

Toledo, Saginaw & Muskegon.—This New Michigan road, 96 miles in length, is a part of the Toledo, Ann Arbor & North Michigan system and is to be open for business by Dec. 15. The following officers have been elected: President, David Robinson, Jr., of Toledo; Vice-President and Manager W. V. McCracken, of New York; Secretary and Treasurer, William Baker of Toledo; Auditor and Freight and Passenger Agent, I K. McCracken, of Fort Wayne.

Shenango & Allegheny.—This road is to be extended at once from Greenville, Pa., to Amasa, where connection will be made with the Lake Shore and Nypano roads. The old canal bed railroad near Greenville, abandoned some years ago, is also to be rebuilt.

Indiana Midland.—Tracklaying is in progress on the extension from Ladoga, Ind., to Waveland at the rate of ¼ of a mile per day.

New Projects and Surveys.—*Atlantic & Mississippi.*—President J. H. CABLE of Lafayette, Ind., informs us that this line is to run from St. Louis *via* Fort Wayne to eastern Ohio, a distance of 520 miles. The work is light and grades do not exceed 20 ft. per mile. The profiles have been made and 50 miles have been graded, and contracts are to be let for construction within 60 days, and the line be pushed rapidly to completion. Any further information may be obtained by addressing him.

New York & Boston Rapid Transit.—Engineer-in-Charge, D. C. LINSLEY, states that the final report of the engineering department will be ready by Dec. 1. Four parties of surveyors are still in the field.

Central Indiana.—This company has been incorporated to build a line from Fort Wayne to Terre Haute, 200 miles, by J. W. KERN of Indianapolis and others.

Newburgh & Poughkeepsie.—A stockholders meeting is to be held at Albany, N. Y., Nov. 19, to make arrangements for raising funds for construction.

Southern.

Existing Roads.—*Cape Fear & Yadkin Valley.*—Negotiations are in progress between the railroad managers and the citizens of Wilmington, N. C., concerning the extension to that place from Fayetteville, a distance of 80 miles. It is quite probable that the extension will be surveyed and built at an early date.

Louisville & Nashville.—The grounds are to be graded at once for the company's new shops at Decatur, Ala. The buildings will be of brick and stone and occupy, with the surrounding yards, about 37 acres.

Orange Belt.—An important secret which has leaked into the hands of the Associated Press is to the effect that P. D. ARMOUR is backing this Florida road, and will push the line through to Point Pinellas at once.

Baltimore & Ohio.—The Baltimore, Grafton & Charleston project, which we noted on our Construction Map No. 2, has been organized at Grafton, W. Va., with JOHN BRADSHAW as President and W. H. LIAMS as Secretary and Treasurer.

Tennessee Midland.—The citizens of Nashville, Tenn., who were disappointed in their second attempt to vote municipal aid to this company, are raising a subscription to offer the road, and it remains to be seen whether the remarkable enthusiasm which the Nashvillians displayed in their recent canvass extends down as far as their pockets.——The annual meeting of the company is to be held Dec. 7 at Memphis. The company has purchased 8,000 tons of steel rails, eleven locomotives and considerable other rolling stock. Sixty-four miles are graded between Jackson & Memphis, and some track has been laid.

Lookout Mountain.—About 550 hands are at work grading this road near Chattanooga, Tenn., running to the summit of Lookout Mountain with a grade of 180 ft. per mile. JOHN JAMES is Chief Engineer.

Blue Spring, Orange City & Atlantic.—This Florida road, 30 miles in length was disposed of recently at foreclosure sale for $141,500, to E. R. CHAPMAN of New York City, the principal bondholder.

Western Ry. of Alabama.—At the annual meeting it was voted to relay the Montgomery & Selma division, 50 miles in length, with steel rails.

Maysville & Big Sandy. About 22 miles of track has been laid on this Kentucky road, but operations are mostly suspended on the division between Maysville and Covington, and there is now no probability that the road will be completed before next season.

Hawesville & Pellville Mineral Railway.—

EDITOR ENGINEERING NEWS:

The Hawesville & Pellville Mineral Railway was chartered by the last Kentucky Legislature and organized Oct. 17. The route is from Hawesville, Ky., *via* Pellville, Whitesville and Hartford to Beaver Dam on the Chesapeake, Ohio & Southwestern Railway, a distance of 40 to 45 miles. The route is through a rolling country, but there will be no deep cuts except through the river hill at Hawesville, which will be tunneled. The tunnel will be about 1,200 ft. or less. It will be placed under survey during the winter or early spring. The road is projected in the interest of the land owners along the route, for the purpose of developing the fine mineral region through which it will run. The owners of the land for 5 miles on either side of the route are subscribing the minerals as stock in the road.

We expect that with these mineral rights and other subscriptions, we can command the capital to build the road and to put the mines in operation.

The right of way is being secured, and we hope to be ready to let the contracts in the spring.

D. L. ADAIR, President.

Artesia, Starkville & Grenada.—This Mississippi company propose to build a railroad from Montgomery, Ala., to Helena, Ark., about 300 miles. Of this the line from Artesia to Starkville, 12 miles, owned by the Mobile & Ohio Company, is to be a part. The line has been surveyed from Starkville to Grenada, 70 miles, and right of way has been secured; the work is light and there are no heavy grades. The future of the project depends on securing the necessary capital, which has not yet been done. L. D. MCDOWELL of Starkville, Miss., is President. R. H. ELLIOTT of Memphis, Tenn., is Chief Engineer.

Paris, Frankfort & Georgetown.—A $150,000 subscription has just been voted by Bath county, Ky. The preliminary surveys are completed from Frankfort to Georgetown and the location is in progress.

Macon & Alabama.—The survey is in progress of this line from Macon, Ga., *via* Talbotton to Opelika, Ala.

Nashville & Charleston.—This company has been incorporated at Nashville, Tenn., by A. S. MARKS and others.

Troy & Tiptonville.—

TROY, Tenn., Nov. 11, 1887.

EDITOR ENGINEERING NEWS:

It is the intention of this company to build a line of railroad through the counties of Obion and Lake in Tennessee, and westward to an intersection with the St. Louis & San Francisco R. R., in Arkansas. This line will open up one of the finest timbered portions of country in the Southern States, the county of Obion, through which the road runs almost centrally, has now 100 saw mills in active operation.

The western connections will be the Kansas City, Memphis & Springfield, Iron Mountain, and St. Louis & San Francisco Railroads. Eastern connections are Illinois Central, Nashville, Chattanooga & St. Louis, Mobile & Ohio, and the Newport News & Mississippi Valley Railroads.

The entire contract for construction and equipment has been let to William Ferguson & Co., who now have a large force of men and teams engaged in the work of construction.

The road will be built and operated as an independent line, the money being furnished by a syndicate of New York capitalists.

Any inquiries made to GEO. B. WILSON, the President, will receive attention.

M. HANLEY & Co., Contractors.

Seaboard Air Line.—The Palmetto railroad is now open for traffic from Hamlet, N. C., to Cheraw, S. C., 18 miles. This is a link in the projected through road from Washington, D. C., to Augusta, Ga., which the managers of the Seaboard system intend to build.

The Northwest.

Existing Roads.—*St. Louis & Chicago.*—The contract for building the extension of 75 miles from Springfield to Eureka, Ill., which was let to J. C. Morris & Co. of New York City and sublet to Hamer & Williams, has been cancelled, as the company was unable to find a market for its securities.

Milwaukee, Lake Shore & Western.—The survey just finished for the extension from La Crosse to Wausau, Wis., 160 miles, has been made through a rough and difficult country. A second line is now to be run between the same points *via* Chippewa Falls.

Chicago, Milwaukee & St. Paul.—It is rumored that right of way is being secured for a line from Milton Junction to Libertyville, Ill., about 60 miles, which if built will shorten the distance from St. Paul to Chicago, very materially.

Chicago, Burlington & Quincy.—The Portage & Southwestern company has been incorporated in this interest, and proposes a road from Portage, Wis., to East Dubuque, Ill., with a branch to Madison, Wis., a total of 135 miles.——Work is to begin soon on an extension of the Burlington & Missouri River system from Ashland, Neb., *via* Weeping Water and Avoca to Nebraska City.

Duluth & Iron Range.—About 600 men are at work on the extension to Ely, for which Shepard, Winston & Co., have the contract.

Red River Valley.—An agreement has been reached between the citizens' committee and contractors Mann & Holt, and Mr. Holt is now in the East negotiating for funds. Meanwhile the officers of the Manitoba government are industriously quarreling and accusing each other of "boodling" in connection with the Hudson Bay and Red River Valley roads, and are doing more to hurt their scheme financially than its enemies did at its first inception.

Dakota.—The present mileage of railroads in the territory is 4,307. Of this, 716 miles of track have been laid since Jan. 1. There are also 301 miles of road ready for tracklaying, most of which will not be completed till next season.

Chicago, Santa Fé & California.—About 200 miles of track has been laid on the Chicago & Kansas City road, and 12 gangs are pushing the work.

Indiana & Illinois Southern.—The line from Effingham to Robinson, Ill., has been altered to standard gauge.

Des Moines, Osceola & Southern.—M. V. B. EDGERLY, of Springfield, Mass., representing the purchasing bondholders committee, bought this road at the foreclosure sale at Des Moines, Nov. 11.——It has been intended to put the road in good condition and complete it as originally projected to St. Joseph or Kansas City, but it is now stated that a consolidation will be effected with some one of the great systems.

Fremont, Elkhorn & Missouri Valley.—The extension from the Platte river to Geneva, Neb., 110 miles, has been completed and opened for traffic.

Northern Pacific.—Trains are now running to Pembina, Dak., over the New Duluth & Manitoba road.

New Projects and Surveys.—*Canada, La Crosse & Southwestern.*—At the annual meeting of this company held at La Crosse, Wis., on Nov. 9, J. A. ROSIENE, of Charles City, Ia., was elected President, and S. S. BURTON, of La Crosse, Treasurer.

Mississippi, Faribault & Northwestern.—A preliminary survey has been completed from Faribault, Minn., to Willmar, and engineers are now working from Faribault southeast *via* Marion. HUDSON WILSON, of Faribault, is interested.

Duluth, Red Wing & Southern.—About $750,000 has been raised by local subscriptions to this projected line.—At a recent meeting of the directors F. W. HOYT, of Red Wing, Minn., was chosen President. The proposed consolidation with the Sioux City & Southwestern project will probably be effected.

Fox River Valley.—A company has been organized to build a railroad from Oshkosh, to Berlin, Wis., 23 miles.

The Southwest.

Existing Roads.—*Texas & Pacific.*—The reorganization of the company is to be followed by great improvements in the equipment and permanent way. The company has heretofore used the tracks of the Galveston, Harrisburg & San Antonio road from Sierra Blanca to El Paso, 92 miles. An independent line is to be built and also a bridge across the Rio Grande at El Paso, the existing one, used by both the Santa Fé and Mexican Central trains, being insufficient to carry the traffic. It is stated that at the recent public sale of the road at Marshall, Tex., the Santa Fé bid $6,500,000 for the property, but it was finally knocked down to Gen. WISTAR, the representative of the bondholders' purchasing committee, for $10,000,000.

Denver, Texas & Fort Worth.—Tracklaying is completed for about 300 miles from Fort Worth northwest, and is expected to reach the State line by Jan. 15.

Pine Bluff, Monroe & New Orleans.—Grading has begun on the extension from Pine Bluff, to Little Rock Ark.

St. Louis, Arkansas & Texas.—The extension from Commerce, Tex., to Fort Worth has been opened for business to Greenville, and tracklaying is finished for 25 miles farther.

Missouri Pacific.—The Augusta & White River Railroad, in Arkansas, has been completed and opened for traffic.

St. Louis & San Francisco.—A project is being agitated at Bonham, Tex., for an extension from Arthur City, near the crossing of the Red River, *via* Bonham to Fort Worth, about 150 miles.

New Projects and Surveys.—*El Paso & Northwestern Ry. & Telegraph Co.*—This company has filed articles of incorporation in Texas, and proposes the construction of a line from El Paso *via* Las Vegas, N. M., to a connection with the Santa Fe and Rock Island systems in the Texas Panhandle, a distance of about 500 miles. The company is successor to the defunct El Paso, St. Louis & Chicago company and at its head are Hon. WM. WINDOM, of Minnesota and STEPHEN W. DORSEY.

Chicago, Jefferson City, Girard & El Paso.—The city of Girard, Kan., has voted aid to this corporation.

Topeka Belt Ry.—Chartered at Topeka, Kas., by J. H. BROADDUS and others.

Lawrence, Atchison & Southern.—The surveyors have run a line from Atchison to Lawrence, Kan., and are working south toward Indian Territory. Capt. STERNBERG, of Lawrence is Chief Engineer.

Leavenworth & Denver Short Line.—The survey of the western division of the line has begun under direction of JOHN MCCARTY. All the money necessary to pay for the survey has not yet been subscribed and the citizens of Leavenworth are entreated to "respond heartily and promptly" to the call for more funds. If the projectors of this enterprise have to wax so eloquent for months together to raise funds for a hasty preliminary survey, how do they expect to raise the money necessary to build and equip their 500 mile Air Line?

Rocky Mountain and Pacific.

Existing Roads.—*San Francisco, Clear Lake & Humboldt.*—A prospectus has been issued by the company showing the proposed route from Napa, Cal., to the mouth of Eel river, Humboldt county, and the following report as to the probable traffic of the road is given by the engineer, J. D. THOMPSON.

It is estimated that there is tributary to this road, capable of cultivation in grain and fruit, 650,000 acres. An annual yield of 50,000 tons, requiring 2500 cars for transportation, can be produced on the grain land embraced.

The business which the company expects to do is set forth in the following table:

Gross annual business of Napa County (freight)	$75,000
Of Lake County (freight)	174,900
Of Mendocino County (freight)	33,500
Live stock	25,500
Passengers	220,000
Back freight	75,000
Total	$603,000
Total expenses	375,000
Annual net earnings	$228,000
Cost of road	$1,885,000

JOHN T. DAVIS has the contract for 25 miles, and has begun grading.

Mexican Central.—Reports from El Paso state that the company is crowded with freight and has ordered 10 locomotives and 250 box cars. An additional amount of rolling stock will be required to equip the Guadalajara and San Luis Potosi lines, now under way.

Mexican International.—The connection with the Mexican Central is to be reached by Dec. 1.

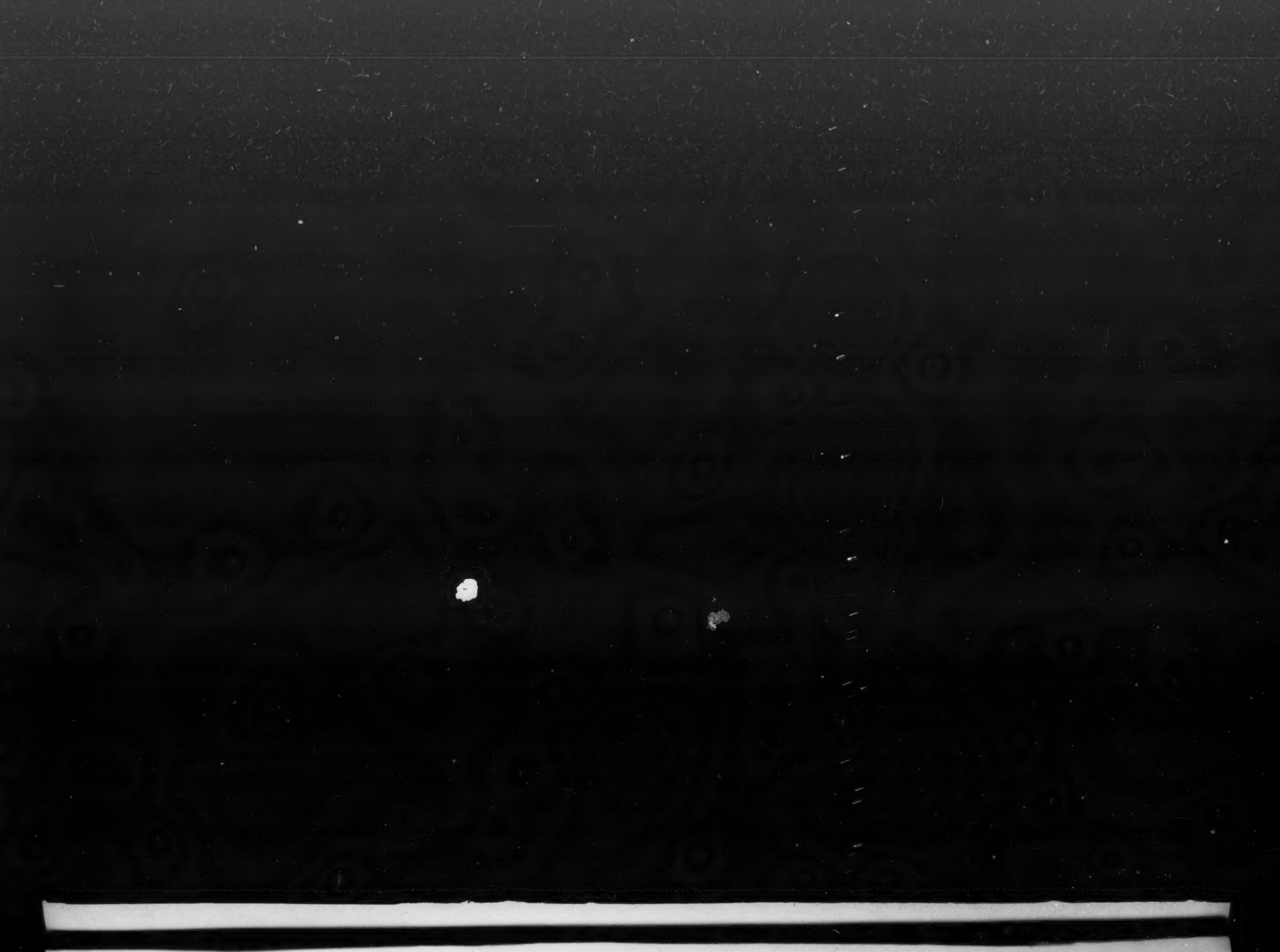
Southern Pacific.—The directors have decided to change the location of the line through the Cienega canyon in Arizona on account of the frequent washouts which have occurred there.——A surveying party is working in Cache Creek canyon on the Woodland, Capay & Clear Lake road.

Pacific Coast.—On the extension to Santa Barbara, Cal., tracklaying is finished to Los Olivos.

Union Pacific.—The Cheyenne & Northern extension has been opened for business from Cheyenne, Wyo., to the North Platte river, about 100 miles.

Coeur d' Alene Ry. & Navigation Co.—The injunction against the operation of a portion of the road brought by the Washington & Idaho Company has been dissolved. Work is to be pushed on the Canyon creek branch, and trains will be run to Burke by Dec. 1.

New Projects and Surveys.—*Chino Valley Narrow Gauge.*—Surveys are in progress for a road from Chino to Ontario in San Bernardino county, Cal.

Mexico.—A rumor at Vera Cruz is to the effect that English capitalists are to push work at once on the projected railway from Vera Cruz to Acapulco.——A narrow-gauge railway is projected to run from Patzquaro, the terminus of the Morelia section of the Mexican National Ry., to the Pacific Coast. It will receive Government aid.——A railway is to be built from the City of Mexico across the mountains to Puebla, a distance of 65 miles air line, but through very difficult country.

Nevada.—A project is being agitated at Virginia City for building a railroad from Eureka, Humboldt county, Nev., to a connection with the California & Oregon road at Cottonwood, Shasta county, Cal., a distance of over 200 miles.